VEGETABLES EAST

FUNGICIDE BENEFITS ASSESSMENT

National Agricultural Pesticide Impact Assessment Program (NAPIAP)

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VEGETABLES - EAST

January, 1991

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This Report Represents a Portion of the USDA/States
National Agricultural Pesticide Impact Assessment Programs (NAPIAP)
Fungicide Assessment Project

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PREFACE

Plant diseases affect all the major food crops world-wide and must be controlled to prevent significant production losses and maintain food quality for animals and humans. In addition, fungicides are a necessary factor in maintaining the availability of fiber and landscape improvements ranging from forest management to enhancements through the use of ornamentals. Agricultural fungicides are a significant component in effective disease control and are critical to plant health management systems. Fungicides provide benefits to producers as well as consumers and to local as well as national economies. Farmers benefit from the prevention of yield losses, improved crop quality, enhanced market opportunities, facilitation of farmwork and harvest. Consumers also benefit from an ample, varied, safe, healthy and inexpensive food supply that is available throughout the year.

This is one of 11 separate reports that assessed the beneficial aspects of fungicide use in U.S. agriculture. The 11 reports, all using a commodity approach in evaluating fungicide use, comprise the Fungicide Benefits Assessment. This assessment represents one part of the USDA/States National Agricultural Pesticide Impact Assessment Program's Fungicide Assessment Project. The two other parts deal with (a.) a treatise examining the health and environmental factors associated with the agricultural use of fungicides, and (b.) an assessment of the status as well as the management strategies for fungal resistance to fungicides in the U.S.

The 11 Fungicide Benefits Assessment reports were prepared by a team of scientists (team leaders). The team leaders and the listing of their reports (by commodity) in the Fungicide Benefits Assessment are as follows:

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INTRODUCTION

The Environmental Protection Agency is currently reviewing the major fungicides used in the United States. In order to accurately assess the importance of fungicides to U.S. agriculture, the National Agricultural Pesticide Impact Assessment Program initiated a program to provide benefits information on the major fungicides used in U.S. agricultural production. The report which follows is a compilation of fungicide-use data collected by Extension plant pathologists in vegetable-producing states East of the Mississippi. Information was collected for 23 vegetables or vegetable crop groupings. Data were submitted for 4 of the major fungicides (EBDC fungicides, chlorothalonil, benomyl and captan) used on vegetables. The following aspects of fungicide use were surveyed:

1. Number of acres planted
2. Rate(s) of fungicides used
3. Number of fungicide applications made
4. Method of fungicide application
5. Percentage of acreage treated with each fungicide
6. Target diseases for which fungicides were applied
7. Percent yield loss anticipated without fungicide
8. Percent yield loss anticipated without the specific fungicide used
9 Alternative fungicides

Fungicide use information is presented in tabular form for each of the four fungicides surveyed. Other means of control in the absence of fungicides is presented in narrative form for each crop.

I. BACKGROUND

Vegetable disease incidence differs substantially between the western and eastern U.S. because of differing environmental conditions in each area. The humid, wet conditions of the eastern U.S. mandate more intense use of fungicide to insure disease-free produce, whereas, the drier, arid conditions of vegetable production in western U.S. enable a lower frequency of fungicide use in most years. To reflect the differences in disease incidence in the regions, two separate reports are presented for vegetables. All states west of the Mississippi River are presented in the Vegetable-West report, while all states east of the Mississippi River are reported in the Vegetable-East report.

Vegetable production requires quality disease-free produce in order to be marketed effectively. In the case of fresh-market vegetables, wholesale brokers or consumers at direct markets will not accept blemished vegetables. For processing vegetables, processors will not accept diseased produce in order to have a final product which has a mold count below federal standards. For these reasons, growers have to protect their vegetables from diseases that not only lower yield but also lower quality.

One of the preferred and effective means of control is the use of disease-resistant varieties. There are numerous vegetable varieties that possess resistance to one or more diseases. While many of the varieties are in use, fungicide use is still necessary in many cases. In some instances, disease pressure is so great that the resistant reaction (usually smaller lesions than susceptible varieties) can still result in lower yield and poor quality. In other situations, other diseases may be present in the area to which the varieties do not possess resistance and fungicide use is needed. Occasionally, resistant varieties do not possess sufficient horticultural characteristics as susceptible varieties, and processors, brokers or consumers demand the use of susceptible varieties.

For a few vegetables (Botrytis leaf blight-onions, early blight-tomatoes, and late blight-white potatoes) disease forecasting systems are being used by growers to determine the frequency of fungicide applications. During periods of dry weather, fungicide schedules (intervals between application) are extended and during periods of favorable environmental conditions for disease development, fungicide schedules are reduced.

The major fungicides used in vegetable production are the EBDC's and chlorothalonil. Benomyl is used to supplement control with EBDC's and chlorothalonil for certain diseases. Captan is a principal fungicide used for seed treatment and plant bed drenches to prevent damping-off of seeds and seedlings. Certain vegetable diseases have fungicides available with a specific mode of action. The dicarboximide fungicides (iprodione and vinclozolin) are used to control vegetable diseases caused by Botrytis sp. and Sclerotinia sp. Metalaxyl is specific for downy mildew control in various vegetables. Triadimefon is used to control powdery mildew of cucurbits.

The major use vegetable fungicides, EBDC's and chlorothalonil, have a broad spectrum of activity. For this reason, there is little possibility of pathogens developing resistance to EBDC fungicides or chlorothalonil. While the specific fungicides, such as the dicarboximides, metalaxyl and triadimefon, are generally more effective on certain diseases, there is a good potential for pathogens to develop resistance to these fungicides if they are used consistently alone. Therefore, the specific fungicides are either formulated with an EBDC or chlorothalonil or used in combination with an EBDC or chlorothalonil in spray schedules.

The potential loss of EBDC fungicides presents a serious threat to the successful control of vegetable diseases. In several crops such as peppers and spinach, there are no adequate alternatives to EBDC fungicides. The only alternatives are copper fungicides. In the case of peppers, maneb is combined with copper fungicides to control bacterial leaf spot. Bacterial pathogens of pepper are resistant to copper fungicides; therefore, there are no viable alternatives to the loss of EBDC's on peppers. Also, for certain vegetables (such as white potato), the loss of EBDC fungicides will put many growers at an economic disadvantage, and they will have to stop producing the crop. The alternatives to EBDC fungicides are 2-3 times as expensive and the profit margin for potatoes is too low to be able to economically use the alternatives.

The following section of the survey includes a narrative of fungicide use on each of twenty-three vegetables or vegetable groupings, as well as a statistical summary of fungicide use on vegetables by each state in the region. For the number of applications, percent acres treated and percent yield loss without control sections, data are given as a range rather than a specific value. Environmental conditions vary from season to season. When environmental conditions are conducive to disease development, higher rates are used, more applications are made, and more acres are treated. Yield losses vary from season to season, due to environmental conditions as well. Information was supplied by Extension Plant Pathologists in each state and reflects an expert opinion of fungicide use on vegetables in each state.

II. SPECIFIC VEGETABLE FUNGICIDE USE INFORMATION

Asparagus
Beans
Beets
Carrots
Celery
Cole Crops
Cucumber
Eggplant
Endive (Escarole)
Leeks
Lettuce
Melon
Onions
Parsnips
Peas
Peppers
Pumpkins
Spinach
Squash
Sweet Corn
Sweet Potato
Tomato
White Potato

ASPARAGUS

The major diseases of asparagus are Fusarium root and crown rot (Fusarium oxysporum f. sp. asparagi and F. moniliforme), rust (Puccinia asparagi), Stemphylium leaf spot (Stemphylium vesicarium), and Cercospora leaf spot (Cercospora asparagi). Fusarium root and crown rot is controlled by crop rotation, use of disease-free planting stock, and utilization of a harvesting regime that minimizes pressure on younger fields. Rust, Stemphylium and Cercospora leaf spots are all foliar diseases which primarily attack the crop after the harvest season is over and during the nonharvestable reproductive fernstalk period of growth.

Benomyl and captan are used in preplant crown dips to protect against Fusarium root and crown rot. Both fungicides are also used as seed treatments to prevent against preemergence damping-off. Treated plants will not be harvested for 2-3 years after treatment.

EBDC fungicides are the only fungicides registered for control of foliar disease of asparagus. Without control of foliar diseases, defoliation of fernstalks can result under favorable environmental conditions. Necrosis of fernstalk reduces the amount of stored food reserves in asparagus crown leading to increased incidence of Fusarium crown rot and yield reductions.

Specific fungicide use data are presented in Tables 1, 2, and 3.

Table 1
ASPARAGUS - EBDC

State	No. Acres planted	Rates lb ai/A	No. Appl.	Method applic.	% Acres treated	Target diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other chemicals
CT	10	2.0	1-2	Foliar	20-30	Rust			
DE	320			Foliar	33	Rust			
FL	0								
GA	0								
IL	62	0.5	1	Cr. foliar dip	10	Seedl.bl., Fusar., rust, Cercosp.			Metalaxyl
IN	400	1.6	2-3	Foliar	20-40	Rust	10-20	10-20	
KY	20	2.0	2	Foliar	50	Rust	10	10	
MA	400	1.2	2	Foliar	25	Rust	5	5	
MD	500	1.6	2-3	Foliar	50	Rust	25-35	25-35	
ME	50	0							
MI	21000	1.0	3-4	Foliar	75	Rust, Stemphylium	30	30	
NC	1200	1.6-2.4	4-6	Foliar	85	Cercospora	60	60	
NJ	1800	1.6	3-4	Foliar	30	Rust	50	50	
NY		0.8 lb/10gal	1	Crown dip	50	Fusarium			Benomyl
	375	1.5	2-3	Foliar	20	Rust	5-50	5-50	
OH	100	1.6	6-8	Foliar	25	Rust	25	25	
PA	700	1.6	1-3	Foliar	30	Rust	50	50	
RI	0								
SC	40	1.6	3	Foliar	50+	Rust	20-50+	20-50+	
TN	14	1.6	1-4	Foliar	25	Rust, Cercospora	50	50	
VA	200	1.6	3-4	Foliar	100	Rust	10	10	
VT	40	1.6	3-4	Foliar	30	Rust	50	50	
WI	500	1.6	1-2;Post	Foliar	10	Rust	<10	<10	
Total	27731								
Average					40.4		30.5	30.5	

Table 2

ASPARAGUS - BENOMYL

State	Rates lb ai/A	No. Appl	Method of Applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o benomyl	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA								
MD	0.5/100 gal	1	root dip		Fusarium	20-30	20-30	
ME								
NC	1 lb/100 gal	1	Seed trmt.	60	Fusarium	10	10	
NJ	1 lb/100 gal	1	Dip	60	Fusarium	10	10	
NY								
OH								
PA	0.5 lb/100 gal	1	Root dip	50	Fusarium	15	15	
RI								
SC								
TN								
VA								
VT	1 lb/100 gal	1	Dip	60	Fusarium	10	10	
WI								
Average:				57.0		14.0	14.0	

Table 3

ASPARAGUS - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL	1.5/100 gal	1	Preplant dip	25	Root rots			EBDC
IN								
KY								
MA								
MD								
ME								
MI								
NC	3 lb/100 gal	1	Crown dip	20	Crown rot	10	10	Benomyl
NJ								
NY								
OH	1.5/100 gal	1	Prepl. root dip	80	Fusarium, Botrytis, Phoma, Pen	25	25	
PA								
RI								
SC								
TN		1	Prepl. root dip	25	Fus. root rot	75	75	EBDC
VA								
VT								
WI								
Average				37.5		36.7	36.7	

BEANS (GREEN AND DRY)

Fungicide-use data for beans are presented in Tables 4, 5, 6,and 7. The bean grouping includes green beans (snap and lima) and dry beans.

The primary diseases of beans are rust (Uromyces phaseoli typica), anthracnose (Colletotrichum lindemuthianum), Alternaria leaf spot (Alternaria fasiculata), and white mold (Sclerotinia sclerotiorum), while downy mildew (Phytophthora phaseoli) is an additional disease of lima beans. Resistant varieties are available for rust control. However, fungicides are still needed in the majority of cases due to lack of horticulturally acceptable qualities. Processors require growers to grow specific varieties precluding the growers the opportunity to grow resistant cultivars. No alternative control measures to fungicides are available for control of anthracnose and Alternaria leaf spot. Control strategies for white mold include crop rotation and row spacing to reduce canopy closure when possible. Downy mildew is only a problem on lima beans. Resistant varieties are available; however, resistant races of the pathogen have developed to the majority of the varieties.

Maneb, an EBDC fungicide, and chlorothalonil are the principal fungicides used for the control of rust and other leaf spots of beans. Both fungicides are equally effective in controlling these diseases. Benomyl is used on bean for the control of white mold. Generally only two applications applied during the bloom period are needed for control. Alternatives to benomyl are the dicarboximide fungicides (iprodione and vinclozolin) and thiophanate-methyl. Maneb (EBDC) is the only fungicide available for use on lima beans for control of downy mildew. There are no viable alternatives for control.

Captan is used as a seed-treatment fungicide on beans to prevent preemergence damping-off. Alternative seed treatments are metalaxyl and chloroneb, but neither fungicide has a broad a spectrum of activity as captan.

Table 4
BEANS (GREEN & DRY) - EBDC

State	No. acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other chemicals
CT	1000	1.6	2-4	Foliar	100	Rust, Anthracnose	30	5	Copper
DE	16500					Downy Mildew			
FL	48000	1.2	6	Foliar	70	Rust, Alternaria	25	5	Chlorothalonil
GA	13500	1.2-1.6	6	Foliar	70	Rust, Alternaria	25	5	Chlorothalonil
IL	8010								
IN	800								
KY	200	1.6	2	Foliar	20	Rust, Anthracnose	10	2	Chlorothalonil
MA	700	1.0	1	Foliar	50	Downy mildew, Anthrac.	10	2	Basicop,chlorothalonil
MD	3500	1.6	2-3	Foliar	15-25	Rust, downy mildew	15-30	5	Chlorothalonil
ME	100								
MI	243000	0.8-2.4	3-4	Foliar	75	Rust, Anthracnose	20	5	Chlorothalonil
NC	6700	1.2-1.6	4-6	Foliar	20	Rust, leaf spots	40	5	Copper, sulfur, chlorothalonil
NJ	12000	1.2-1.6	3	Foliar	20	Rust, downy mildew	25	5	Chlorothalonil
NY	61600								
OH	2000	2.4	3-5	Foliar	50	Anthracnose	25-50	5	Chlorothalonil
PA	8000	0.8-2.4	4	Foliar	5	Rust, Anthracnose	5	0-2	Chlorothalonil
RI	30	0.8-2.4	2	Foliar	100	Anthracnose,downy mil.			Copper sulfate
SC	4200	1.6	4-5	Foliar	75	Rust, Anthracnose	20-90	5	Chlorothalonil
TN	10000	1.6	2-4	Foliar	80	Anthracnose,rust	30	2	Sulfur + chlorothalonil, basic copper
VA	6200	1.6	2-4	Foliar	75	Rust	10	2	Chlorothalonil
VT	62	1.2-1.6	3	Foliar	20	Rust, downy mildew	25	5	Chlorothalonil
WI	92400								
Total	538502								
Average					53.4		24.7	4	

Table 5

BEANS (GREEN & DRY) - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other chemicals
CT	1-1.5	2-4	Foliar	100	Botrytis			
DE								
FL	2.2	2-3	Foliar	70	Rust, Alternaria			EBDC
GA	2.2	3	Foliar	75	Rust, Alternaria	10	5	EBDC
IL	1.5	2-3	Foliar	10-20	Rust, Anthracnose			Thiophanate-methyl, EBDC, iprodione, benomyl
IN								
KY	1.2	2	Foliar	10	Rust	10	2	EBDC
MA	1.8	1	Foliar	25	Rust			EBDC, Basicop
MD	2.25	2-3	Foliar	15	Rust			EBDC
ME								
MI	2.2	1-2	Foliar	50	Botrytis,rust,Anthracnose	20	5	Copper
NC	2.25	4-6	Foliar	10	Leaf spots, rust	40	5	EBDC
NJ	2.25	4	Foliar	20	Rust	10-50	5	EBDC
NY								
OH	1.5-2.2	3-5	Foliar	50	Anthracnose	25-50	5	EBDC
PA	1.5-2.0	4	Foliar	5	Rust, Anthracnose	5	0-2	EBDC
RI								
SC	2.25	3-4	Foliar	90+	Rust, Anthracnose	50-90	5	EBDC
TN								
VA	2.25	2-4	Foliar	75	Rust	10	2	EBDC
VT	2.25	4	Foliar	20	Rust	10-50	5	EBDC
WI								
Average				42.3		26.2	4.3	

Table 6
BEANS (GREEN & DRY) - BENOMYL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o benomyl	Other Chemicals
CT	1.0	2	Foliar	100	Sclerotinia			
DE								
FL	0.75-1.0	2	Foliar	60	Sclerotinia			Thiophanate-methyl
GA	0.75-1.0	2	Foliar	50	Sclerotinia	20	2	Thiophanate-methyl
IL	0.75	2-4	Foliar	10	Sclerotinia			Iprodione, dicloran
IN	1.0	2-3	Foliar	40-60	Sclerotinia	20-30	0-2	Iprodione, thiophanate-methyl
KY								
MA								
MD								
ME	1.0	1-2	Foliar	30-40	Sclerotinia	25	5	Thiophanate-methyl
MI	0.75	1-2	Foliar	50	Sclerotinia, Botrytis	15	2	
NC	0.25-1.0	4-6	Foliar	10	Rust, leaf spots	40	5	EBDC, chlorothalonil
NJ	0.5-1.0	2	Foliar	10	Sclerotinia, Botrytis	50	2	Thiophanate-methyl, iprodione
NY	0.5	1-2	Foliar	5-25	Sclerotinia, Botrytis	15-50	2-5	Vinclozolin, iprodione
OH	1.0	2	Foliar	50	Sclerotinia, Botrytis	10-50	2	Chlorothalonil, thiophanate-methyl
PA	0.75-1.0	1-2	Foliar	25-50	Sclerotinia, Botrytis	20	0-2	Thiophanate-methyl, iprodione
RI	0.75-1.0	2	Foliar	100	Sclerotinia			Thiophanate-methyl
SC								
TN								
VA	0.5-1.0	2	Foliar	75	Sclerotinia, Botrytis	5	0-2	Thiophanate-methyl
VT	0.5-1.0	2	Foliar	10	Sclerotinia, Botrytis	50	2	Thiophanate-methyl, iprodione
WI	0.75-1.0	1-2	Foliar	75	Sclerotinia, Botrytis	20	0-2	Iprodione, vinclozolin, thiophanate-methyl
Average				48.4		31.9		

Table 7

BEANS (GREEN & DRY) - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY		1	Seed trmt.	20	Damping-off	10	10	
MA								
MD	2oz/Cwt	1	Seed-slurry	100	Damping-off, seed rot	10-15	5	Thiram + chloroneb, metalaxyl
ME								
MI								
NC								
NJ			Seed trmt.					
NY	1.25oz/Cwt	1	Seed trmt.	100	Damping-off, seed rot	50-90	5	Chloroneb, PCNB, metalaxyl
OH								
PA	5-6 2.5-3.0	1bdcast 1band	Seed dust Seed trmt.	10% soil 50% seed	Root rot Seed rot	10	2	Metalaxyl
RI								
SC								
TN			Treated seed	80-100	Pythium, Fusarium	20	10	Thiram
VA			Treated seed	100	Pythium, Fusarium	30	10	Thiram
VT			Seed trmt.					
WI			Treated seed	100	Pythium, Fusarium	20	20	

BEETS

The primary disease that attacks beets is Cercospora leaf spot (Cercospora beticola). Crop rotation is an important means of control. However, under environmental conditions of high humidity and moderate temperatures, fungicides are needed to prevent infection. Copper fungicides are the only fungicides available for use on beets for Cercospora leaf spot control.

Several soil-borne fungi cause damping-off of beet seedlings. Captan seed treatment is an important preventative control for damping-off. The specific information concerning beet acreage and captan use is presented in Table 8.

Table 8

BEETS - CAPTAN

State	No. acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other chemicals
CT	15								
DE	0								
FL	0								
GA									
IL	130								
IN	0								
KY	0								
MA	300								
MD	100								
ME	30								
MI	145000								
NC	100								
NJ	500								
NY	2400								
OH	250		1	Seed trmt.	100	Pythium, Fusarium,Phytoph.	15-75	15-75	
PA	250	3.5-6 oz/Cwt	1	Seed trmt.	50	Damping-off, seed rots	10	5	Thiram
RI									
SC	50								
TN									
VA	100								
VT	15								
WI	4500								
Total	153740								

CARROTS

The primary diseases present on carrots are Cercospora leaf blight (Cercospora carotae) and Alternaria leaf blight (Alternaria dauci). Carrots grown for fresh market generally take 60-90 days to maturity, whereas, processing carrots require 150 days from seeding to harvest. Leaves need to be protected from leaf blights during the majority of the growing season; therefore, numerous fungicide applications are required for control. States where the majority of the acreage is grown for fresh market would use fewer fungicide applications than the states which produce primarily processing carrots. The predominant fungicides used for leaf blight control are the EBDC fungicides since they are less expensive to use. Chlorothalonil is an alternative fungicide; yet it is too costly to use in many cases due to the numerous applications required.

Other important carrot diseases include crater rot (Rhizoctonia carotae) and cottony soft rot (Sclerotinia sclerotiorum). Benomyl is used as a foliar spray to assist in controlling these diseases. Generally only 2 applications are required for control.

Table 9

CARROT - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	40	1.2-1.6	2-4	Foliar		Cercospora, Alternaria			
DE	400		6-7	Foliar	80	Alternaria			Chlorothalonil
FL	13000	1.5-2.0	5	Foliar	100	Cercospora, Alternaria			Iprodione, chlorothalonil
GA									
IL	0								
IN	0								
KY	0								
MA	450	1.6	2	Foliar	50	Alternaria, Cercospora	10	2	Chlorothalonil
MD	500	1.2-1.6	4-6	Foliar	50	Leaf blight	15-20	2	Fixed copper, iprodione,chlorothalonil
ME	50	1.6	2	Foliar	40	Leaf blight	10	2	Chlorothalonil
MI	7500	1.0-1.5	8-12	Foliar	100	Alternaria, Cercospora			Chlorothalonil
NC	100	1.2-1.6	3	Foliar	75	Leaf spots	40	2-5	Duter, chlorothalonil
NJ	750	1.6	8	Foliar	100	Alternaria, Cercospora	20	5	Iprodione, chlorothalonil
NY	1200	1.2-1.6	4-8	Foliar	100	Alternaria, Cercospora	20-50	5	Chlorothalonil
OH	1500	1.6	3-5	Foliar	100	Alternaria, Cercospora	25-75	5	Chlorothalonil
PA	300	1.6	3-5	Foliar	40	Leaf blight	10	2	Iprodione, chlorothalonil
RI									
SC	0								
TN	0								
VA	0								
VT	50	1.6	6-8	Foliar	75-100	Alternaria, Cercospora	20	2	Chlorothalonil, anilizine
WI	4000	1.2-1.6	6-10	Foliar	100	Alternaria, Cercospora	20	2	Duter, Super Tin, Triple Tin, chlorothaloni
Total	29840								
Average					79.6		23.2		

Table 10

CARROTS - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres Treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT	0.75	2-4	Foliar		Alternaria, Cercospora			
DE				20				EBDC
FL	1.5-2.0	5	Foliar	100	Cercospora, Alternaria			EBDC, iprodione
GA								
IL								
IN								
KY								
MA	1.8	2	Foliar		Alternaria, Cercospora	10	2	EBDC
MD	1.5	4-6	Foliar	50	Leaf blight	15-20	3	EBDC, iprodione, copper
ME	1.4	2	Foliar	40	Leaf blight	10	2	EBDC
MI	1.0-1.5	8-12	Foliar	100	Alternaria, Cercospora			EBDC
NC	1.1-1.5	3	Foliar	10	Leaf spots	40	2	EBDC
NJ	1.25-1.5	5	Foliar	25	Leaf blights	75-100	5	EBDC, iprodione
NY	0.8-1.1	2-4	Foliar	100	Alternaria, Cercospora	20-50	3	EBDC
OH	1.5	3-5	Foliar	100	Alternaria, Cercospora	25-75	5	EBDC
PA	1.13-1.6	4	Foliar	40	Leaf blight	10	2	EBDC, iprodione
RI								
SC								
TN								
VA								
VT	1.25	5	Foliar	25	Alternaria, Cercospora	60	3	EBDC
WI	1.1-1.4	6-10	Foliar	100	Alternaria, Cercospora	20	2	Duter, Super Tin, Triple Tin
Average				59.2		21.8		

Table 11

CARROTS - BENOMYL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o benomyl	Other Chemicals
CT								
DE								
FL	0.25-0.5	2	Foliar	100	Sclerotinia			
GA								
IL								
IN								
KY								
MA								
MD								
ME								
MI								
NC	0.125-0.5	3	Foliar	10	Leaf spots	40	2	EBDC, chlorothalonil
NJ								
NY								
OH								
PA								
RI								
SC								
TN								
VA								
VT								
WI	0.75-1.0	1-2	Foliar	100	Rhizoctonia, Sclerotinia	20	5	
Average				70.0		22.5	3.5	

CELERY

The primary diseases prevalent on celery are early blight (Cercospora apii) and late blight (Septoria apiicola). Celery generally requires 90-125 days from planting to maturity. Leaf blights can develop during transplant production on through the growing season. Since the leaves are the marketable portions of the plant, it is imperative to have disease-free leaves in order to market the crop. It is for this reason that in states (Florida, etc.) where environmental conditions are favorable for disease development, 30-40 fungicide applications are required to produce the crop. The predominant fungicides used are the EBDC fungicides. They are efficacious as well as relatively inexpensive to use. Chlorothalonil and benomyl are highly efficacious, yet they are more costly to use than the EBDC fungicides. The majority of growers alternate fungicides during the growing season for several reasons. During periods of intense disease pressure chlorothalonil or benomyl will be used and during periods of less disease pressure (dry weather) the EBDC fungicides will be used. Also, alternating fungicides is an important strategy to prevent fungal resistance from developing to the more specific fungicides (benomyl, etc.). Other alternative fungicides used to a lesser extent include anilizine and thiophanate methyl.

Table 12
CELERY-EBDC

State	No. acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other chemicals
CT	0								
DE	0								
FL	9000	1.6	30-40	Foliar	100	Ea.blight,late bl.,bact.blight	20-40	2	Anilizine, chlorothalonil
GA									
IL	0								
IN	0								
KY	0								
MA	10	1.5	3	Foliar	100	Cercosp.,Septoria,Rhizoctonia	25	2	Copper, thiophanate-methyl,chlorothalonil
MD	0								
ME	0								
MI	3500	1.25-1.5	8-12	Foliar	100	Cercospora, Septoria	100	4	Anilazine, chlorothalonil
NC	100	1.2-1.6	3	Foliar	10	Leaf spots	20	2	Anilazine, copper, dicloran, chlorothalonil
NJ	100	1.2-1.6	5	Foliar	100	Cercospora, Septoria	40	2	Anilazine, thiophanate-methyl, chlorothalonil, benomyl, copper
NY	430	1.6	6-10	Foliar	100	Cercospora, Septoria	20-50	4	Chlorothalonil, benomyl
OH	450	1.6	8-10	Foliar	100	Cercospora, Septoria	25-100	5	Thiophanate-methyl, chlorothalonil
PA	450	1.2-1.6	6-10	Foliar	30	Ea.blight,late blight	80	5	Anilazine, thiophanate-methyl, copper, chlorothalonil, benomyl
RI									
SC	0								
TN	0								
VA	0								
VT	3	1.2-1.6	5	Foliar	100	Cercospora, Septoria	45	2	Anilazine, thiophanate-methyl, chlorothalonil, benomyl, copper
WI	400	1.2-1.7	10-12	Foliar	10	Cercospora, Septoria	20	2	Anilazine
Total	14443								
Average					75.0		35.2	3	

Table 13

CELERY - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT								
DE								
FL	1.5-2.25	10	Foliar	30	Ea.blight, late bl.,stalk rot	20-40	4	Anilazine, EBDC
GA								
IL								
IN								
KY								
MA	1.8	2	Foliar	100	Cercosp.,Septoria,Rhizoctonia	25	2	EBDC, copper, thiophanate-methyl
MD								
ME								
MI	1.25-1.5	8-12	Foliar	100	Cercospora,Septoria	100	25	Anilazine, EBDC
NC	1.5-2.2	3	Foliar	5	Leaf spots	20	2	EBDC, anilazine, benomyl
NJ	1.5-2.25	2-5	Foliar	20-100	Basal stalk rot,leaf blight	40	15	Benomyl,EBDC,copper,anilazine, thiophanate-methyl
NY	0.54-1.62	2-6	Foliar	100	Bas.stlk,pk.root,Cerco.,Septo.	20-50	5	EBDC, benomyl
OH	2.0	8-10	Foliar	100	Cercospora,Septoria	25-100	5	EBDC, thiophanate-methyl
PA	1.5-2.25	6-10	Foliar	60	Ea.blight,late blight	80	10	EBDC, anilazine, copper, benomyl, thiophanate-methyl
RI								
SC								
TN								
VA								
VT	1.5-2.25	2-5	Foliar	20-100	Basal stalk rot, leaf blight	40	10	Benomyl, EBDC, copper, anilazine, thiophanate-methyl
WI	0.7-1.1	10-12	Foliar	100	Cercospora, Septoria	20	5	Anilazine, copper
Average				73.5		39.8	8.1	

Table 14

CELERY - BENOMYL

State	Rates lb ai/A	No. Appl.	Method applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o benomyl	Other Chemicals
CT								
DE								
FL	0.25	2	Foliar	20	Ea. blight, stalk rot			Chlorothalonil
GA								
IL								
IN								
KY								
MA								
MD								
ME								
MI	1.25-1.5	8-12	Foliar	100	Cercospora, Septoria	100	20	Anilazine
NC	0.125-0.25	3	Foliar	5	Leaf spots	20	2	Anilazine, EBDC, chlorothalonil
NJ	0.25	5	Foliar	100	Leaf blight	40	2	Chlorothalonil,EBDC, copper, thiophanate-methyl, anilazine
NY	0.13-0.25	2-4	Foliar	10-30	Cercospora, Septoria	20-50	5	EBDC, chlorothalonil, anilazine
OH	0.25	8-10	Foliar	100	Cercospora, Septoria			EBDC, thiophanate-methyl
PA	0.25	3-5	Foliar	5	Ea. blight, late blight	80	5	EBDC, chlorothalonil, anilazine, copper, thiophanate-methyl
RI								
SC								
TN								
VA								
VT	0.25	5	Foliar	100	Leaf blight	40	20	Chlorothalonil, EBDC, copper, thiophanate-methyl,anilazine
WI	0.12-0.25	10-12	Foliar	100	Cercospora, Septoria	20	2	Thiophanate-methyl, anilazine
Average				62.2		33.9	8	

COLE CROPS

Cole crops include cabbage, cauliflower, broccoli, brussels sprouts, and numerous Chinese vegetables. Diseases are similar on each cole crop listed and in the majority of cases, fungicides are registered on all of the cole crop grouping. For this reason, cole crops are reported as a single crop in the survey.

The primary diseases on cole crops are downy mildew (Peronospora parasitica) and Alternaria leaf spot (Alternaria brassicae). Downy mildew is present during the majority of the production period in the southeastern states; whereas, it is generally only present during the fall crop in the northeastern states. Maneb (EBDC fungicide) and chlorothalonil are the predominate fungicides used for control. Metalaxyl is a highly efficacious fungicide for control of downy mildew. However, metalaxyl cannot be used alone as a foliar application because the pathogen will develop resistance. Therefore, metalaxyl is prepared as a prepack mixture with chlorothalonil for use on cole crops for downy mildew control. General fungicide-use pattern on cole crops involves protective applications of maneb or chlorothalonil until any downy mildew develops. Once downy mildew becomes present in the area, chlorothalonil/metalaxyl is applied to get the best control of downy mildew. Applications of maneb and chlorothalonil also provide control of Alternaria leaf spot.

Occasionally white mold (Sclerotinia sclerotiorum) attacks cole crops. Benomyl is used to provide control and generally only 2 applications are needed. There are no alternative fungicides for control. Cultural control measures include good weed control to avoid providing a source of organic matter infection by ascospores of Sclerotinia.

Damping-off caused by soil-borne fungi is a problem in both transplant production and in direct-seeded fields. Captan is a necessary seed treatment for prevention of damping-off. Also captan is needed as a plant bed drench for the prevention of postemergence damping-off.

Table 15

COLE CROPS - EBDC
(CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS, ETC.)

State	No. acres planted	Rates lb ai/A	No. Appl.	Method applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	600	1.0-2.0	1-4	Foliar	50	Alternaria			Chlorothalonil
DE	750			Foliar	50	Bl.rot,Alternaria, downy mildew			Chlorothalonil
FL	15600	1.6	1-7	Foliar	70	Downy mildew,Alternaria	20-80	4	Chlorothalonil, metalaxyl/chlorothalonil
GA	6000	1.6	6	Foliar	90	Downy mildew,Alternaria	15-75	4	Chlorothalonil, metalaxyl/chlorothalonil
IL	2529	1.0	1-2	Foliar	10-20	Downy mildew,Alternaria	10-80	5	Chlorothalonil, metalaxyl
IN	1500	1.6	2-4	Foliar	60-80	Alternaria, downy mildew	5-40	5	Chlorothalonil
KY	600	2.4	2	Foliar	5	Downy mildew, leaf spots	10	3	Chlorothalonil
MA	1500	1.5	2	Foliar	75	Alternaria	20	4	Copper, metalaxyl/chlorothalonil, chlorothalonil
MD	1000	2.4	3-4	Foliar	20	Downy mildew, Alternaria	10-20	5	Copper, chlorothalonil, metalaxyl/chlorothalonil
ME	3100								
MI	3000	1.6	5-9	Foliar	85	Downy mildew, Alternaria	30	5	Chlorothalonil
NC	12000	1.2	2	Foliar	40	Downy mildew, Alternaria	30	4	Metalaxyl, chlorothalonil,iprodione
NJ	6000	1.2-1.6	4	Foliar	50	Downy mildew, Alternaria	20	2	Metalaxyl/chlorothalonil, chlorothalonil
NY	15700	0.8	2-10	Foliar	30-100	Downy mildew,Alternaria	15-80	5	Metalaxyl/chlorothalonil, chlorothalonil
OH	3250								
PA	7000	0.8-2.4	1-6	Foliar	35	Downy mildew, Alternaria	10	3	Copper, chlorothalonil
RI	100	2.4	2	Foliar	99	Alternaria			Metalaxyl/chlorothalonil
SC	2500	1.6	8-9	Foliar	80-90	Alternaria, downy mildew	50-90	4	Copper, chlorothalonil
TN	1500	1.2	2-3	Foliar	40	Downy mildew, Alternaria	5-20	2	Chlorothalonil
VA	2900	2.4	2-4	Foliar	40-100	Downy mildew, Alternaria	10	4	Metalaxyl/chlorothalonil, chlorothalonil
VT	180	1.2-1.6	4	Foliar	50	Downy mildew, Alternaria	20	2	Metalaxyl/chlorothalonil, chlorothalonil
WI	9500	1.2-1.6	2-4	Foliar	25	Downy mildew, Alternaria	5-10	2	Metalaxyl/chlorothalonil, chlorothalonil
Total	96809								
Average					59.2		23.8	3.7	

Table 16

COLE CROPS - CHLOROTHALONIL
(CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS, ETC.)

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT	1.0	2-4	Foliar	50	Downy mildew, Alternaria			EBDC, metalaxyl
DE								
FL	1.125	1-7	Foliar	70	Downy mildew, Alternaria	20-80	2	EBDC
GA	1.25	6	Foliar	80	Downy mildew, Alternaria	15-75	2	EBDC
IL	1.0	2-4	Foliar	15	Downy mild.,Altern.,Cercospora	10-80	3	EBDC, metalaxyl
IN								
KY	1.1	2	Foliar	5	Downy mildew, leaf spots	10	2	EBDC
MA	1.5	2	Foliar	75	Alternaria	20	3	EBDC, metalaxyl/chlorothalonil
MD	1.2	3-4	Foliar	20	Downy mildew, Alternaria	10-20	3	EBDC, copper, metalaxyl/chlorothalonil
ME	1.35-2.25	1-2	Foliar	20	Downy mildew, Alternaria	10-25	4	Copper
MI	1.1	5-6	Foliar	85	Downy mildew, Alternaria	30	4	EBDC
NC	1.1	3	Foliar	10	Downy mildew, Alternaria	30	6	EBDC,metalaxyl
NJ	1.25	3	Foliar	50	Downy mildew, Alternaria	20	5	Metalaxyl/chlorothalonil, EBDC
NY	0.9	2-6	Foliar	90-100	Downy mildew, Alternaria	15-80	2	EBDC
OH	1.2	4-8	Foliar	100	Downy mildew, Alternaria	10-90	5	Metalaxyl/chlorothalonil
PA	1.3	1-6	Foliar	35	Downy mildew, Alternaria	10	2	EBDC, copper
RI	1.0	3	Foliar	99	Downy mildew, Alternaria			
SC	0.8-1.3	8-9	Foliar	80-90	Alternaria, downy mildew	50-90	2	EBDC
TN	1.1	2-3	Foliar	40	Downy mildew, Alternaria	5-20	5	EBDC
VA	1.125	2-4	Foliar	100	Downy mildew, Alternaria	10	3	EBDC, metalaxyl/chlorothalonil
VT	1.25	3	Foliar	50	Downy mildew, Alternaria	20	5	Metalaxyl/chlorothalonil, EBDC
WI	1.0	1-5	Foliar	25-50	Downy mildew, Alternaria	5-10	4	EBDC + zinc, metalaxyl/chlorothalonil
Average:				57.2		25.6	2.8	

Table 17

COLE CROPS - BENOMYL
(CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS, ETC.)

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o benomyl	Other chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA								
MD								
ME								
MI	0.25	2-3	Foliar	50	Sclerotinia	15	15	
NC								
NJ	0.25	2	Foliar	1	White mold	1	1	
NY								
OH								
PA	0.25	1-6	Foliar	5	Sclerotinia	2	2	
RI								
SC								
TN								
VA								
VT	0.25	2	Foliar	1	Sclerotinia	1	1	
WI								
Average				14.2		4.8	4.8	

Table 18

COLE CROPS - CAPTAN
(CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS, ETC.)

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield losses w/o fungicides	% Yield losses w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA								
MD	1.25/Cwt	1	Seed trmt.	100	Damping-off, seed rot			Thiram
ME								
MI								
NC								
NJ								
NY	7.5 lb	1	Soil trmt.	1% soil	Seed rots			Thiram
OH			+Thiram tr.seed	90	Pythium, Fusarium	25	25	Metalaxyl
PA	1.8 oz/Cwt	1	Seed trmt	50% seed	Damping-off	25	25	Thiram, PCNB, metalaxyl
RI								
SC								
TN	Seed bed drench			100	Pythium, Fusarium	20	25	PCNB
VA								
VT								
WI	Treated seed			75-100	Pythium, Fusarium	10		

CUCUMBER

Numerous diseases attack cucumbers and each can result in high yield losses if not controlled. The major cucumber diseases are anthracnose (Colletotrichum lagenarium), target spot (Corynespora cassiicola), downy mildew (Pseudoperonospora cubensis), powdery mildew (Sphaerotheca fuligenea, Erysiphe cichoracearum), Alternaria leaf spot (Alternaria cucumerina), scab (Cladosporium cucumerinum), gummy stem blight (Didymella bryoniae), and belly rot (Rhizoctonia solani). There are numerous disease-resistant varieties available for one or more cucumber diseases. Some varieties possess resistance to anthracnose, scab, downy mildew, and powdery mildew. Varieties with broad-spectrum disease resistance have substantially reduced the need for fungicide usage in some production areas in the midwest and northeast. In other production areas, diseases for which resistance is not available are present and fungicides are needed. Also, in many cases, environmental conditions are so favorable for disease development that the disease-resistant reaction (small lesions rather than large lesions) still results in defoliation and yield loss.

The majority of cucumber diseases are controlled by either EBDC fungicides or chlorothalonil. Both fungicides are broad spectrum in activity. Chlorothalonil is more efficacious on powdery mildew than the EBDC's and generally chlorothalonil is combined with benomyl for control of anthracnose. For downy mildew control, either chlorothalonil/metalaxyl or EBDC/metalaxyl prepack mixtures are applied for control. Metalaxyl is highly effective against downy mildew, but metalaxyl cannot be applied alone for downy mildew control so that the downy mildew pathogen doesn't develop resistance to the fungicide. Triadimefon provides excellent control of one genus of powdery mildew (Erysiphe) but only partial control of the predominant cucumber powdery mildew (Sphaerotheca). Powdery mildew is tolerant to benomyl. Control of powdery mildew depends upon triadimefon, chlorothalonil, or sulfur.

Captan is used as a seed-treatment fungicide and a plant bed drench treatment to prevent damping-off. Both are important uses necessary to establish a proper stand of cucumbers.

Table 19

CUCUMBERS - EBDC

State	No. acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	150	1.6-2.4	6-10	Foliar		P.M.,scab,leaf spot, stem bl.			
DE	3000		3-4	Foliar	5-20				Chlorothalonil
FL	15600	1.6-2.4	1-7	Foliar	85	Downy mildew, target spot	>100		Chlorothalonil, benomyl
GA	8000	1.6-2.4	1-7	Foliar	80	Downy mildew, target spot	100		Chlorothalonil, benomyl
IL	2000	2.5	2-4	Foliar	10	Altern., Anthrac.,gummy stem	5-50		Chlorothalonil, benomyl
IN	2500	1.6-2.4	1-4	Foliar	20-40	Altern., Anthrac.,gummy stem	5-15		Chlorothalonil
KY	1250	1.6	5	Foliar	50	Altern.,Anthr,p.mild.,gum.stem			Chlorothalonil
MA	1500	1.2	3	Foliar	100	Anthr.downy mild.,scab,Cercos.	60		Metalaxyl/chlorothalonil, chlorothalonil
MD	5000	2.4	5-6	Foliar	75	Anth,belly rot,g.stem,DM,scab			Fixed copper, chlorothalonil
ME	90	2.0	2	Foliar	50	Powd.mildew,downy mild.,Anthr.	20		Chlorothalonil, triadimefon, dinocap
MI	28000	1.6	8-9	Foliar	95	Anthracnose,Altern.,black rot	40		Chlorothalonil
NC	35000	1.2	3-9	Foliar	70	Leaf spots, fruit rots	50		Copper, anilazine, sulfur, triadimefon, chlorothalonil
NJ	3000	1.2-2.5	4	Foliar	80	P.m.,d.m.,Anthr.,gummy stem	60		Metalaxyl/chlorothalonil, thiophanate-methyl, chlorothalonil, benomyl
NY	3100								
OH	5000	2.4	3-5	Foliar	15	Anthrac.,Altern.,gummy stem	25		Thiophanate-methyl, chlorothalonil, benomyl
PA	550	2.4	1-4	Foliar	25	Scab,Anthr.,Altern.,D.mildew	0-75		Thiophanate-methyl, triadimefon, dinocap, Dikar, chlorothalonil, benomyl
RI									
SC	12800	1.6	5-10	Foliar	60-90	Downy mildew,gummy stem	50-70		Copper, chlorothalonil
TN	500	1.6	1-5	Foliar	70	Altern,Anthr,gum.stem,d.mild	50		Chlorothalonil
VA	3600	1.6-2.4	4-6	Foliar	50-75	Anthrac.,belly rot,gummy stem	50		Thiophanate-methyl, chlorothalonil, benomyl
VT	50	1.2-2.25	4	Foliar	80	P.M.,D.M.,Anth.,scab,gum.stem	60		Metalaxyl/chlorothalonil, thiophanate-methyl, chlorothalonil, benomyl
WI	7-8000	1.6	1-6	Foliar	20	Anthracnose,Alternaria	5		Anilazine
Total	130690								
Average					59.5		47.2		

Table 20

CUCUMBER - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield losses w/o fungicides	% Yield losses w/o chlorothalonil	Other Chemicals
CT	0.6-1.25	6-10	Foliar	50	Powd.mild.,leaf spot,stem bl.			
DE		3-4	Foliar	80	Leaf spots			EBDC
	8.25 pt	1		10	Belly rot			
FL	2.25	1-3	Foliar	85	Downy mildew, target spot	100	50	EBDC, benomyl
GA	2.25	3	Foliar	80	Downy mildew, target spot	100	50	EBDC, benomyl
IL	1.5-2.0	2-4	Foliar	75	Gum.stem,scab,Altern.,Anthrac.	5-50	10	EBDC, benomyl
IN	1.5	2-4	Foliar	20-40	Altern.,Anthr.,gummy stem	5-15	10	EBDC
KY	2.0	5	Foliar	50	Altern.Anthr,p.mild.,gum.stem			EBDC
MA	2.0	3	Foliar	100	Anthr.,scab.,Cercosp.,mildew	60	20	EBDC, metalaxyl/chlorothalonil
MD	2.25	5-6	Foliar	75	Anthr,bel.rot,DM,scab,gum.stem			Copper, EBDC
ME								
MI	1.1	8-9	Foliar	95	Anthrac.,Altern.,black rot			EBDC
NC	1.5	3-9	Foliar	10	Leaf spots, fruit rots			EBDC, anilazine, copper
NJ	1.1-2.25	2-4	Foliar	10-80	Anthr,bel.rot,gum.stem,PM,scab	5-80	50	EBDC, metalaxyl/EBDC, benomyl, thiophanate-methyl
NY	1.08-1.62	2-6	Foliar	30-50	Anthr,Altern,d.mild.,p.mild.	20-50		EBDC, benomyl, triadimefon, metalaxyl/chlorothalonil
OH	2.0-6.25	1-5	Foliar or soil	10-25	Anthr,Altern,d.mild.,belly rot	25	10	EBDC, benomyl
PA	2.25	1-4	Foliar	25	Scab,Anthr,Altern.,down.mild.	0-75	10	EBDC, benomyl, thiophanate-methyl, dinocap, Dikar, triadimefon
RI								
SC	0.8-2.25	5-10	Foliar	30-40	Downy mild.,Anthr.,gummy stem			EBDC
	2.25	1	Soil	50	Fruit rots	30-50	30-50	
TN	1.1-2.3	1-5	Foliar	10	Altern,Anthr,gum.stem.,d.mild.	50	10	EBDC
VA	1.125-2.25	4-6	Foliar	50-75	Anthr.,belly rot,gum.stem,scab	50	50	EBDC, benomyl, thiophanate-methyl
VT	1.1-2.25	2-4	Foliar	10-80	Anthr,bel.rot,gum.stem,PM,scab	80	40	EBDC, metalaxyl/EBDC, benomyl, thiophanate-methyl
WI	1.5	1-6	Foliar	20	Anthr.,powd.mild.,Alternaria	5	3	Anilazine
Average				54.8		44.1		

Table 21

CUCUMBER - BENOMYL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield losses w/o fungicides	% Yield losses w/o benomyl	Other Chemicals
CT	0.12-0.25	2-4	Foliar		PM,scab, leaf spot, stem blight			
DE								
FL								
GA	0.25	3	Foliar		Anthracnose	50	7	EBDC, chlorothalonil
IL	0.5	1-3	Foliar	10	Gummy stem, Alternaria	5-50	5	EBDC, chlorothalonil
IN	0.50	1-3	Foliar	20-40	Anthracnose	5-30	7	Thiophanate-methyl, chlorothalonil
KY	0.25	5	Foliar	50	Altern,.Anthr.,PM,gum.stem		5	EBDC, chlorothalonil
MA								
MD	0.25	5-6	Foliar	75	Anthr.,belly rot,DM,gum.stem	20-30	5	Copper
ME	0.25	1	Foliar	50	Powd.mild.downy mild.,Anthr.			Chlorothalonil, triadimefon, dinocap
MI								
NC	0.2	3-9	Foliar	8	Leaf spots, fruit rots			EBDC, chlorothalonil, triadimefon, copper
NJ	0.25	4	Foliar	80	Anthr.,belly rot, gummy stem	30-80	5	Thiophanate-methyl, chlorothalonil, EBDC
NY	0.13-0.25	1-3	Foliar	30-50	Anthr.,powd.mild.,gummy stem	20-50	4	EBDC, chlorothalonil, triadimefon
OH	0.25	3-4	Foliar	15	Anthr.,Altern.,powd.mildew	20	5	Triadimefon, thiophanate-methyl, EBDC, chlorothalonil, dinocap
PA	0.13-0.25	1-4	Foliar	25	Powd.mildew,Anthracnose	0-75	4	Chlorothalonil, thiophanate-methyl, EBDC, dinocap, Dikar, triadimefon
RI								
SC								
TN								
VA	0.25-0.5	4-6	Foliar	50-75	Anthr.,belly rot, gummy stem	50	7	Thiophanate-methyl
VT	0.25	4	Foliar	80	Anthr.,belly rot, gum.stem	30-80	5	Thiophanate-methyl, chlorothalonil, EBDC
WI	0.12-0.25	1-6	Foliar	20	Anthr.,powd.mildew,Altern.			Anilazine
Average				44.5		36.0	5.4	

Table 22

CUCUMBER - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY		1	Seed trmt.	75	Damping-off			
MA								
MD	1.25/Cwt.	1	Seed trmt.	100	Damping-off, seed rot	10-15	2	Metalaxyl
ME								
MI								
NC								
NJ			Seed trmt	pl.bed drench				
NY								
OH	Treated seed			100	Damping-off	25-75	2	Thiram, metalaxyl
PA		1	Seed trmt	50	Damping-off, seed rot	0-10	2	Thiram
RI								
SC								
TN								
VA								
VT			Seed trmt	pl. bed drench				
WI	Treated seed			95	Damping-off	10		

EGGPLANT

The primary foliar and fruit diseases of eggplant are Phomopsis blight (Phomopsis vexans), Alternaria blight (Alternaria solani) and anthracnose fruit rot (Collectotrichum sp.). Eggplant production occurs over a long time period (120 days) requiring protective fungicide application for disease control during the time that fruit form until the end of the growing season. EBDC fungicides (maneb) are the primary fungicides used for control. The only alternative fungicides are copper fungicides.

Benomyl has supplemental labels in some states for damping-off control caused by Rhizoctonia solani. In these states, benomyl is combined with captan as a plant bed drench to control damping-off caused by soil-borne fungi.

Table 23

EGGPLANT - EBDC

State	No. acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	100								Comments: None
DE	10				50	Phomopsis fruit rot			
FL	2300	1.2	16	Foliar	80	Phomopsis	25	20	
GA									
IL	120								
IN									
KY	2								Comments: N/A
MA	75	1.5	2	Foliar	100	Phomopsis	30	25	
MD	100	1.6	3-4	Foliar	25	Fruit rot	20-30	20-30	Fixed copper, metalaxyl
ME	10								
MI	800								Comments: No labels
NC	630	1.2-1.6	3-6	Foliar	40	Phoma	60	50	Sulfur
NJ	900	1.2-1.6	4	Foliar	20	Phomopsis, fruit rot	5	3	Copper
NY	100								
OH	50								Comments: No labels
PA	300	1.2-1.6	1-3	Foliar	50	Fruit rot	5	5	
RI	25	0.4-0.6 qt	4	Foliar	99	Phomopsis, fruit rot			
SC	25	0.4-0.59	6	Foliar	100	Fruit rot, Anthracnose	100	75	
TN	65	1.6	1-5	Foliar	70	Leaf spots, fruit rots	50	40	Copper
VA	0								
VT	5	1.2-1.6	4	Foliar	20	Phomopsis, fruit rot	5		Copper
WI	50								Comments: None used
Total	5667								
Average					59.4		33.9		

Table 24

EGGPLANT - BENOMYL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o benomyl	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA								
MD	0.5/100 gal	1-3	Pl. bed drench	Damping-off				
ME								
MI								
NC								
NJ	0.5 lb/100 gal	1	Pl. bed drench	Damping-off				
NY								
OH								
PA								
RI								
SC								
TN								
VA								
VT								
WI								

Table 25

EGGPLANT - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA								
MD	0.5/100 gal	1-3	Pl.bed drench		Damping-off			Metalaxyl, fumigation
ME								
MI								
NC	5-6	1	Pl.bed drench	20	Damping-off	40	30	Fumigation
NJ	0.5 lb/100gal	1	Pl.bed drench		Damping-off			
NY								
OH								Comments: No labels
PA	0.5 lb/100 gal	1-3	Sp.dr.to pl.bed	5	Damping-off	1-2	1	Metalaxyl
RI			Treated seed		Damping-off			
SC								
TN								
VA								
VT	0.5 lb/100 gal	1	Pl.bed drench		Damping-off			
WI								

ENDIVE, ESCAROLE

The primary diseases of endive and escarole are downy mildew (*Bremia lactuca*), Alternaria leaf spot (*Alternaria* sp.), and Septoria leaf spot (*Septoria lactuca*). EBDC fungicides (maneb) are the primary fungicides used on endive and escarole. The only alternative fungicides are copper fungicides. Phytotoxicity is possible when copper fungicides are used at the full rate for the entire season.

Table 26

ENDIVE, ESCAROLE - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	8								
DE	0								
FL	5000	1.2-1.6	4	Foliar	33	Downy mildew, Alternaria	5-15	5-15	
GA									
IL	0								
IN	0								
KY	0								
MA	150								
MD	50								
ME	10								
MI	0								
NC	100	1.2-1.6	2	Foliar	10	Leaf spots	10	10	Dicloran
NJ	1500	1.2-1.6	3-5	Foliar	50	Downy mildew, Septoria	50	40	
NY	100	1.6-2.4	2-3	Foliar	100		25-75	25-75	
OH	1800								
PA	100								
RI									
SC	0								
TN	0								
VA	0								
VT	5	1.2-1.6	3-5	Foliar	50	Downy mildew, Septoria	50	40	
WI	10								
Total	8833								
Average					48.6		34.0	30	

Table 27

ENDIVE, ESCAROLE - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA								
MD								
ME								
MI								
NC								
NJ								
NY								
OH			Treated seed	100	Damping-off	25	25	Thiram
PA								
RI								
SC								
TN								
VA								
VT								
WI								

LEEKS

The primary diseases on leeks are downy mildew (*Peronospora destructor*), purple blotch (*Alternaria porri*), and blast (*Botrytis cinerea*). The primary fungicide used for control of these diseases is chlorothalonil. In some cases, the EBDC fungicides are used for control.

Table 28

LEEKS - EBDC

State	No. acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT									
DE									
FL	100	1.6-2.4	10-15	Foliar	90-100	Downy mild.,purp.blotch,blast	5-15	2	Iprodione, chlorothalonil
GA									
IL	100								
IN									
KY	0								
MA	3								
MD	10								
ME	10								
MI	0								
NC	50								
NJ	500								
NY									
OH	10								
PA	25								
RI									
SC	0								
TN	0								
VA	0								
VT	3								
WI	5-10								
Total	811				95.0		10.0	2	

Table 29

LEEKS - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT								
DE								
FL	0.9-1.5	8-12	Foliar	0-10	Downy mild.purp.blotch,blast	5-15	10	Iprodione
GA								
IL	1.0	2-3	Foliar	80	Botrytis	10-40	10-40	
IN								
MA								
MD	1.1-2.2	4	Foliar	20	Purple blotch, downy mildew			
ME								
MI								
NC	1.2-2.2	3	Foliar	20	Leaf spots	20	20	
NJ	1.1-2.25	3	Foliar	70	Purple blotch,downy mildew	5-10	5-10	
NY								
OH	2.25	3	Foliar	75	Purp.blotch,blast,downy mild.	25-80	25-80	
PA	2.25	3	Foliar		Purp.blotch,downy mildew	20	20	
RI								
SC								
TN								
VA								
VT	1.1-2.25	3	Foliar	70	Purple blotch,downy mildew	5-10	5-10	
WI								
Average				49.2		20.4		

LETTUCE

The primary lettuce diseases are downy mildew (*Bremia lactuca*), Alternaria leaf spot (*Alternaria* sp.), Septoria leaf spot (*Septoria lactuca*), and drop (*Sclerotinia minor* and *Sclerotinia sclerotiorum*). EBDC fungicides (maneb) are the primary fungicides used for downy mildew and leaf spots. Downy mildew can result in serious losses in a brief period of time under favorable environmental conditions. Some states have emergency registrations in place for use of metalaxyl or phosethyl-Al for control of downy mildew.

Leaf spots are sporadic in occurrence and can be severe when environmental conditions are favorable for disease development. Alternative control measures for leaf spots would be copper fungicides. Phytotoxicity can result from full season use with the high labeled rate of copper fungicides.

Lettuce drop is a limiting factor for lettuce production in the northeast and north central regions of the United States. The dicarboximide fungicides (iprodione and vinclozolin) are the primary fungicides used. Dicloran is registered for use on lettuce for control of drop but is ineffective. Two to three applications of the dicarboximide fungicides are applied per lettuce crop and the entire acreage is treated. Approximately 50% yield loss could be anticipated without the use of the dicarboximide fungicides.

Table 30

LETTUCE - EBDC

State	No. acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	20								
DE	0								
FL	15000	1.2-2.4	4-6	Foliar	75	Downy mildew, Alternaria	5-35	10	Metalaxyl, aluminum tris.
GA									
IL	0								
IN									Comments: N/A
KY	10								
MA	1000								Comments: none
MD	10								Comments: not labeled
ME	0								
MI	1500								
NC	150	1.2-1.6	2	Foliar	8	Leafspots, rots	20	5	Metalaxyl, iprodione, vinclozolin, sulfur, dicloran, benomyl
NJ	3600	1.2-1.6	3	Foliar	40	Leaf spots, downy mildew	20	15	Copper
NY	3200	1.6-2.4	2-3	Foliar	100	Downy mildew	25-75	10	Metalaxyl
OH	1000	2.4	2	Foliar	15	Downy mildew	25-75	25-75	
PA	600	None							
RI	30								
SC									
TN	0								
VA	50								
VT	120	1.2-1.6	3	Foliar	40	Leaf spots, downy mildew	20	5	Copper
WI	20	None							
Total	26310								
Average					46.3		30.0		

Table 31

LETTUCE - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA								
MD								
ME								
MI								
NC	1.0	2	Foliar	5	Leaf spots, rots	20	5	EBDC, benomyl, metalaxyl, dicloran, vinclozolin, iprodione
NJ								
NY								
OH			Treated seed	90	Damping-off			Thiram, metalaxyl
PA								
RI								
SC								
TN								
VA								
VT								
WI								

MELONS

The melon grouping includes muskmelons and watermelons. The primary diseases prevalent on melons include Alternaria leaf blight (Alternaria cucumerina), gummy stem blight (Didymella bryoniae), anthracnose (Colletotrichum lagenarium), downy mildew (Pseudoperonospora cubensis), powdery mildew (Erysiphe cichoracearum; Sphaerotheca fuligenea) and scab (Cladosporium cucumerinum).

There are few varieties of muskmelon with resistance to downy mildew, powdery mildew, and Alternaria leaf blight and few varieties of watermelon with resistance to anthracnose. However, in most production areas, other diseases warrant fungicide applications in order to produce a marketable crop.

The major fungicides used are EBDC fungicides and chlorothalonil. Benomyl is generally combined with chlorothalonil for improved anthracnose control. For downy mildew control, metalaxyl/EBDC or metalaxyl/chlorothalonil prepack mixtures are applied. Metalaxyl is highly effective against downy mildew but should be used in combination with another fungicide in order to prevent resistance from developing. Triadimefon is used for powdery mildew control and is highly effective against Erysiphe but only marginally effective against Sphaerotheca. Consequently, triadimefon is used in combination with chlorothalonil.

Captan is used as a seed treatment and plant bed drench for prevention of damping-off. Control of damping-off is essential in order to obtain an adequate plant stand.

Table 32

MELON (MUSKMELON, WATERMELON) - EBDC

State	No. acres Planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	50	1.6-2.4	5-10	Foliar		Scab,Anthr.,stem blight,mild.			Chlorothalonil
DE	1560		3-4	Foliar	20	Leaf blight			Chlorothalonil
FL	51000	1.6-2.4	2-8	Foliar	80-95	Gummy stem,downy mild.,Anthr.	100	10	Chlorothalonil
GA	35000	1.6-2.4	2-8	Foliar	80	Gum.stem,downy mildew,Anthr.	100	10	Chlorothalonil
IL	2500	2.5	2-4	Foliar	30	Altern.,Anthrac.,gummy stem	5-50	5	Chlorothalonil, benomyl, thiophanate-methyl
IN	12000	2.4	4-8	Foliar	60-80	Altern.,Anthrac.,gum.stem	20-60	5	Chlorothalonil,coppers
KY	85	1.6	4	Foliar	40	Downy mild.,Altern.,Anthrac.	20	5	Chlorothalonil
MA	400	1.2	3	Foliar	100	D.mild.,Anthr.,Cercosp.,scab			Chlorothalonil
MD	8000	2.4	4-8	Foliar	50-75	D.mild.,Altern.,scab,gum.stem	75	5	Fixed copper, chlorothalonil
ME	20								Comments: none
MI	2000	1.6	8-9	Foliar	95	Anthracnose, Altern.,black rot	40	5	Chlorothalonil
NC	15700	1.6-2.4	6-10	Foliar	50	Leaf spots			Metalaxyl, triadimefon, anilazine, copper, chlorothalonil
NJ	1200	1.2-2.25	4	Foliar	40	Leaf spots, gummy stem	75	10	Chlorothalonil, thiophanate-methyl, benomyl
NY	300								
OH	600	2.4	6-7	Foliar	75	Altern.,Anthrac.,scab			Thiophanate-methyl, chlorothalonil
PA	4200	1.6-2.4	1-4	Foliar	50	Scab,Anthrac.,Altern.,d.mildew	0-50	5	Thiophanate-methyl, triadimefon, dinocap, Dikar, chlorothalonil, benomyl
RI									
SC	15900	1.6-2.4	5-10	Foliar	50+	Downy mild.,Anthrac.,gum.stem	30-100	10	Chlorothalonil
TN	1600	1.6	1-5	Foliar	70	Altern.,Anthr.,gum.stem.DM	50	10	Chlorothalonil
VA	350								
VT	40	1.2-2.25	4	Foliar	40	Leaf spots, gummy stem	50	5	Thiophanate-methyl, chlorothalonil, benomyl

Table 32 (continued)

WI	500	1.2-1.6	6-10	Foliar	100	Alternaria, Anthracnose	10-20	5	Anilazine, chlorothalonil
Total:	153005								
Average					64.1		47.9	8.4	

Table 33

MELON (MUSKMELON, WATERMELON) - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT	1.12-2.12	5-10	Foliar		Scab,Anthrac.,stem bl., mildews			EBDC
DE		6-8	Foliar	80				EBDC
FL	1.5-2.25	2-8	Foliar	90	Altern.,gummy stem, downy mild.	100	25	EBDC
GA	1.5-2.2	2-8	Foliar	90	Altern.,gum.stem,downy mildew	100	25	EBDC
IL	1.5-2.0	2-4	Foliar	50	Gummy stem, Altern., Anthracnose			EBDC, benomyl, thiophanate-methyl
IN	1.5	4-8	Foliar	80-100	Altern.,Anthrac.,gummy stem	20-60	20	Coppers
KY	1.2	3	Foliar	20	Downy mild.,Altern.,Anthrac.	20	20	EBDC
MA	2.0	2	Foliar	100	Anthr.d.mild.,Cercosp.,scab	50		EBDC
MD	2.25	4-8	Foliar	50-75	D.mild.,Altern.,scab,gum.stem	75	25	EBDC, copper
ME								
MI	2.2	8-9	Foliar	95	Anthracnose, Altern.,black rot			EBDC
NC	1.1-1.5	6-10	Foliar	15	Leaf spots			EBDC, metalaxyl, triadimefon,anilazine
NJ	1.1-2.2	2-4	Foliar	10-90	Altern,scab,Anthrac,DM,gum.stem	75	25	EBDC, metalaxyl/EBDC,benomyl, thiophanate-methyl
NY	1.1-1.6	4-5	Foliar	80	Altern.,scab,d.mild.,p.mild.	50-60		Benomyl, triadimefon, metalaxyl/chlorothalonil
OH	2.25	5-6	Foliar	75	Altern., Anthr.,d.mild.,scab	35		EBDC, thiophanate-methyl, metalaxyl
PA	1.1-2.2	4-8	Foliar	80	Scab, Anthr., Altern.,d.mildew	0-50	10	EBDC, benomyl, thiophanate-methyl, dinocap, Dikar, triadimefon
RI								
SC	0.8-1.6	5-10	Foliar	25	Downy mildew, gummy stem	30-100	25	EBDC
TN	1.1-2.3	1-5	Foliar	10	Altern.,Anthrac.,gum.stem,DM	50	25	EBDC
VA	1.125-2.25	2-4	Foliar	90-100	Altern.,Anthrac.,gum.stem,DM	30	25	Benomyl, metalaxyl/chlorothalonil
VT	1.1-2.2	2-4	Foliar	10-90	Alt.,scab,Anthr.,d.m.,gum.stem	50	20	
WI	1.5	6-10	Foliar	100	Alternaria, Anthracnose	10-20	10	EBDC, anilazine
Average				71.8		43.3	21.3	

Table 34

MELON (MUSKMELON, WATERMELON) - BENOMYL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o benomyl	Other Chemicals
CT								
DE		3-4		<80	Anthracnose, gummy stem			
FL	0.25	1-6	Foliar	90	Gummy stem	100	10	Chlorothalonil
GA	0.25	1-5	Foliar	80	Gummy stem blight	100	?	Chlorothalonil
IL	0.5	1-3	Foliar	40	Gummy stem, Alternaria			EBDC, chlorothalonil, thiophanate-methyl
IN	0.5	1-3	Foliar	50-70	Powdery mildew, Anthracnose	20-60	5	Triadimefon, thiophanate-methyl, chlorothalonil
KY	0.25	2	Foliar	20	Powdery mildew, gummy stem			EBDC, chlorothalonil
MA	0.25	2	Foliar	50	Powdery mildew	25	2	Triadimefon
MD	0.25	4-8	Foliar	50-75	Gummy stem blight			Copper
ME								
MI	0.25	4-5	Foliar	90	Powdery mildew	20	2	Triadimefon
NC	0.125-0.25	15?	Foliar	15	Leaf spots			EBDC, triadimefon
NJ	0.25	2	Foliar	20	Gummy stem blight	2-5	1	Chlorothalonil, EBDC, thiophanate-methyl
NY	0.25	2-3	Foliar	40-50	Anthracnose, downy mildew	40	5	Chlorothalonil, triadimefon
OH	0.25	3	Foliar	50	Powdery mildew	15	2	Dinocap, triadimefon, thiophanate-methyl
PA	0.25	1-4	Foliar	80	Anthracnose, powdery mildew	0-90	5	EBDC, chlorothalonil, thiophanate-methyl, dinocap, Dikar, triadimefon
RI								
SC								
TN								
VA	0.12-0.25	2-4	Foliar	9-100	Gummy stem, Anthracnose	30	5	Thiophanate-methyl, chlorothalonil
VT	0.25	2	Foliar	20	Gummy stem	2-5	1	Chlorothalonil, EBDC, thiophanate-methyl
WI	0.75-1.0	1-2	Foliar	100	Anthracnose	10-20	2	
Average				60.6		35.0	3.2	

Table 35

MELON (MUSKMELON, WATERMELON) - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL	2.0	1-4	Foliar	10	Anthrac.,angular leaf spot			EBDC, chlorothalonil, benomyl, thiophanate-methyl
IN								
KY		1	Seed trmt.	40	Damping-off	10	10	
MA								
MD	1.25 oz/cwt.	1	Seed trmt.	100	Damping-off, seed decay			Thiram
ME								
MI								
NC								
NJ			Seed trmt. &	pl. bed drench				
NY								
OH			Treated seed	100	Damping-off	25-50	5	Thiram, metalaxyl
PA	1.0 lb/100 gal	2	Soil surf.spray	50	Damping-off	0-30	2	Metalaxyl
RI								
SC								
TN		1	Seed bed drench	5	Damping-off	10	10	
VA								
VT			Seed trmt. &	pl. bed drench				
WI								

ONIONS

The major diseases of onions are downy mildew (*Peronospora destructor*), blast (*Botrytis cinerea*) and purple blotch (*Alternaria porri*). Disease forecasting systems are in place in New York and Michigan for Botrytis leaf blight (blast). Fungicides are only applied when sporulation of Botrytis is anticipated, based on environmental conditions. Fungicide use on onions for blast control is designed in a manner to delay the development of resistance to fungicides by the pathogen. EBDC fungicides, chlorothalonil, and the dicarboximide fungicides (iprodione and vinclozolin) are alternated with each other during the season. The dicarboximide fungicides are specific for Botrytis, so the loss of EBDC fungicides and chlorothalonil will drastically shorten the length of time before Botrytis would develop resistance to the dicarboximide fungicides. For downy mildew control, EBDC fungicides and chlorothalonil are used. Metalaxyl is the most efficacious fungicide for downy mildew control. In order to prevent the development of resistance to metalaxyl by the pathogen, metalaxyl can only be applied to onions as a prepack mixture with either EBDC or chlorothalonil.

Table 36
ONION - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	5	2.4	2-4	Foliar		Botrytis, Alternaria			Chlorothalonil
DE	0								
FL	150	1.6-2.4	10-15	Foliar	90-100	Downy mild.,purp.blotch,blast			Iprodione, chlorothalonil
GA	6000	1.6-2.4	10-12	Foliar	95	Down.mild.,purple blotch,blast			Iprodione, chlorothalonil
IL	800	2.0	3-4	Foliar	10	Altern.,Botrytis, downy mildew			Chlorothalonil, iprodione
IN	1000	2.4	4-6	Foliar	60-80	Altern.,purple blotch, d.mildew	5-15	5	Iprodione, chlorothalonil, metalaxyl/chlorothalonil
KY	5	1.6	2	Foliar	10	Downy mildew, purple blotch	10	2	Anilazine, chlorothalonil
MA	200	1.0	2	Foliar	100	Botrytis, downy mild.,Altern.	30	5	Chlorothalonil
MD	50	1.6-2.4	6-8	Foliar	25	Downy mildew,purpl.blotch,blast	15-25	5	Iprodione, chlorothalonil
ME	10								
MI	8500	1.25-1.8	8-12	Foliar	100	Botry.,downy mild.,purp.blotch	50-75	10	Chlorothalonil
NC	300	1.2-1.6	3	Foliar	10	Leaf spots	20	5	Iprodione, metalaxyl, sulfur, dicloran, chlorothalonil
NJ	500	1.6-2.4	5	Foliar	90	Downy mild.,purp.blotch,blast	5-10	5	Metalaxyl/chlorothalonil,iprodione, chlorothalonil
NY	12000	2.4	2-5	Foliar	100	Downy mild.,Botry.,purp.blotch	40-50	25	Iprodione, vinclozolin
OH	1000	2.4	5-7	Foliar	100	Altern.,Botrytis,downy mildew			Iprodione, metalaxyl/chlorothalonil
PA	400	2.4	4-8	Foliar	30	Pur.blotch,Botry,DM,neck rot	0-90	20	Chlorothalonil, anilazine, iprodione
RI									
SC	300	2.25	4-6	Foliar	30	Downy mildew	50	10	Chlorothalonil
TN	30	1.6	1-4	Foliar	50	Downy mildew	20	10	
VA	0								
VT	20	1.6-2.4	5	Foliar	90	Down.mild.,purp.blotch,blast	5-10	5	Metalaxyl/chlorothalonil, iprodione, chlorothalonil
WI	1400	1.6-2.4	6-10	Foliar	100	Botrytis, purple blotch	20	10	Chlorothalonil, anilazine
Total	32670								
Average					65.9		23.6	7.1	

Table 37

ONION - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT	0.45-0.90	2-4	Foliar		Botrytis, Alternaria			EBDC
DE								
FL	0.9-1.5	8-12	Foliar	0-10	Downy mild.,purp.blotch,blast	0-40	10	EBDC, iprodione
GA	0.9-1.5	10	Foliar	5	Down.mild.,purple blotch,blast	25	7	EBDC, iprodione
IL	1.5	3-4	Foliar	80	Downy mildew,Altern.,Botrytis			EBDC, iprodione
IN								
KY	1.2	2	Foliar	5	Downy mildew, purple blotch	10	2	EBDC, anilazine
MA	1.0	2	Foliar	100	Botrytis,downy mild.,Altern.	30	5	EBDC, metalaxyl/chlorothalonil
MD	1.1-2.2	6-8	Foliar	25	Downy mild.,purp.blotch,blast	15-25	5	EBDC, iprodione
ME								
MI	1.25-1.8	4-6	Foliar	100	Botrytis, purple blotch	50-75	10	Anilazine, EBDC
NC	1.17-2.2	3	Foliar	10	Leaf spots	20	5	EBDC, iprodione, metalaxyl
NJ	1.1-2.2	5	Foliar	90	Downy mild.,purp.blotch,blast	5-10	5	EBDC, iprodione
NY	0.54-1.1	2-5	Foliar	50-75	Downy mild.,Botry.,purp.blotch	40-50	30	EBDC, iprodione, metalaxyl/chlorothalonil
OH	2.2	5-7	Foliar	100	Altern.,Botrytis,downy mildew			Iprodione, metalaxyl/chlorothalonil
PA	1.6	4-8	Foliar	40	Altern,Botry.,d.mil.,neck rot	0-90	20	EBDC, anilazine, iprodione
RI								
SC	0.8-1.6	3	Foliar	60	DM,purp.blotch,Botryt.,blast	50	10	EBDC
TN								
VA								
VT	1.1-2.2	5	Foliar	90	Downy mild.,purp.blotch,blast	5-10	5	EBDC, iprodione
WI	0.9-1.6	3-6	Foliar	100	Botrytis, purple blotch			EBDC, anilazine
Average				59.3		28.5	9.1	

Table 38

ONION - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL	2.0	1-3	Foliar	50	Purple blotch,downy mildew			Iprodione, chlorothalonil, EBDC
IN								
KY		1	Seed trmt.	5	Damping-off	1	1	
MA								
MD	1.25 oz/Cwt.	1	Seed trmt.	100	Damping-off, seed decay	10-15	10	Thiram
ME								
MI								
NC								
NJ								
NY								
OH			Treated seed	90	Damping-off			Metalaxyl
PA								
RI								
SC								
TN								
VA								
VT								
WI								

PARSNIPS

The predominant diseases of parsnips include canker (Itersonilia perplexans), Cercospora leaf spot (Cercospora pastinacae), and downy mildew (Plasmopara nivea). Chlorothalonil is the major fungicide used for disease control on parsnips. EBDC and copper fungicides are alternatives. Fungicide application is combined with good cultural practices, such as good weed control and long crop rotations, for good disease management.

Table 39

PARSNIPS - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	0								
DE	0								
FL	0								
GA									
IL	0								
IN									Comments: N/A
KY	0								
MA	100	1.6	2	Foliar	50	Alternaria, Cercospora	10	2	Chlorothalonil
MD	50								
ME	10								Comments: none
MI	0								
NC	20								Comments: not used
NJ	100								
NY	100								
OH	50								Comments: no label
PA	200								Comments: none
RI	-								
SC	0								
TN	0								
VA	0								
VT	2								
WI	10								Comments: none
Total	642								
Average					50		10		

Table 40

PARSNIPS - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA	1.8	2	Foliar		Alternaria, Cercospora	10	5	
MD		3	Foliar	25	Leaf spot, canker, mildew	25-50	5	
ME								
MI								
NC								
NJ	1.1-1.5	3	Foliar	90	Leaf spot	30	10	
NY	0.8-1.1	2-4	Foliar	75-85	Leaf blight	20-50	10	
OH								
PA								
RI								
SC								
TN								
VA								
VT	1.1-1.5	3	Foliar	90	Leaf spots	30	10	
WI								
Average				72.5		22.5		

PEAS

Both green peas and southern peas are included in the peas grouping. The most prevalent diseases of green peas are Ascochyta blight (Ascochyta pisi) and downy mildew (Peronospora pisi). In the majority of years, disease incidence is not severe enough to warrant fungicide applications. Soil-borne fungi are responsible for seed decay and damping-off. Captan seed treatment is the primary fungicide seed treatment used to prevent seed decay and damping-off. Metalaxyl seed treatment is an alternative seed treatment and soil application; however, metalaxyl only controls seed decay and damping-off caused by Phycomycete fungi.

Southern peas produced in the southeastern United States have several important diseases which can limit production. The major diseases are Cercospora leaf spot (Cercospora sp.) and rust (Uromyces fabae). The only fungicide used for control is chlorothalonil.

Table 41

PEAS (GREEN & SOUTHERN) - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	0								
DE	9700								
FL	0								
GA	24000								
IL	11000								
IN									
KY	3								
MA	250								
MD	2000								
ME	4100								
MI	700								
NC	250	1.3-3.2	4-5	Foliar	20	Leaf spot	40	40	Metalaxyl, sulfur
NJ	1000								
NY	27000								
OH	50								
PA	4500								
RI	-								
SC	1500								
TN	600								
VA	100								
VT	65								
WI	80000								
Total	166818								
Average					20.0		40.0	40	

Table 42

PEAS (GREEN & SOUTHERN) - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT								
DE								
FL								
GA	0.75-1.1	6	Foliar	25	Cercospora	25	25	
IL								
IN								
KY								
MA								
MD								
ME								
MI								
NC								
NJ								
NY								
OH								
PA								
RI								
SC	0.75-1.1	6	Foliar	10-20	Cercospora	20+	20+	
TN	1.1	1-2	Foliar	30	Rust, Cercospora	20	20	Comments:specified as Southern peas
VA								
VT								
WI								
Average				25.0		21.7	21.7	

Table 43

PEAS (GREEN & SOUTHERN) - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL	0.75 oz/Cwt.	1	Seed trmt.	20	Root rot, damping-off			Metalaxyl
IN								
KY		1	Seed trmt.	5	Damping-off			
MA								
MD	2.15 oz/Cwt.	1	Seed trmt.	100	Damping-off, seed decay			Metalaxyl, thiram
ME								
MI								
NC								
NJ								
NY	0.75 oz/Cwt.	1	Seed trmt.	90	Seed decay, root rot	50-90	80	Thiram
OH			Treated seed	90				Metalaxyl, thiram
PA		1	Seed trmt.	50	Damping-off, seed rot			Metalaxyl
RI								
SC								
TN								Comment:specified as "Southern Peas"; possibly dry bean?
VA								
VT								
WI			Treated seed	100	Pythium, damping-off	20	20	

PEPPER

The most important disease of peppers is bacterial leaf spot (Xanthomonas campestris pv. vesicatoria). Current control measures involve the use of chlorine-treated seed or seed tested to be free of bacteria. During transplant production and production in the field, control involves the use of copper fungicides used in combination with EBDC fungicides (maneb). Copper fungicides used alone are not as effective as the copper plus maneb combination. More importantly, in large production states of Florida and Georgia, bacterial populations on pepper are resistant to copper fungicides and the only possible control is the combination of copper plus maneb. The recent cancellation of maneb use on peppers has put pepper production in the eastern United States in jeopardy due to lack of effective control measures for bacterial leaf spot.

Other diseases of pepper include Cercospora leaf spot (Cercospora capsici), anthracnose fruit rot (Colletotrichum piperatum and C. capsici), and Phytophthora blight (Phytophthora capsici). EBDC fungicides are used for control of Cercospora leaf spot and anthracnose. In production areas where only anthracnose fruit rot is present, applications are not needed if fruit is being harvested at the mature green stage, because anthracnose fruit rot only appears on mature red peppers. However, in these areas when fruit is harvested beyond the green stage of development, there is no control measure available in the absence of the EBDC fungicides. Cultural practices of raised bed culture integrated with three soil applications of metalaxyl are used for the control of Phytophthora blight.

Captan is used as a seed treatment and a plant bed drench for the control of seed decay and damping-off. Damping-off is a serious disease during transplant production.

Table 44

PEPPER - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	350	0.96-1.28	1-2	Foliar		Cercospora, bacterial blight			
DE	400		4-6	Foliar	90	Bacterial spot, Anthracnose			Copper
FL	19000	0.4-1.6	1-15	Foliar	75-100	Bacterial spot	100	100	Copper
GA	4500	0.4-1.6	10-12	Foliar	100	Bacterial spot	100	100	Copper
IL	2000	1.0-2.0	1-2	Foliar	25	Bacterial spot,Anthracnose	5-50	25	Copper
IN	2500								Metalaxyl
KY	4000	1.6	6	Foliar	25	Bacterial spot	20	10	Copper
MA	1000	1.5	2	Foliar	100	Bacterial spot			Copper, metalaxyl
MD	500	1.6-2.4	6	Foliar		Bacterial spot	50	40	+ fixed copper
ME	15								Comments:none
MI	3000	1.6	6-7	Foliar	95	Cercospora,Anthrac.,bact.spot	35	20	
NC	10000	1.2-1.6	4-5	Foliar	30	Bacterial leaf spot			Copper, captan
NJ	6500	1.2-1.6	8	Foliar	100	Bacterial leaf spot,Anthrac.	80	60	Copper
NY	600								
OH	1100	1.5	4-6	Foliar	75-100	Anthracnose, early blight	25-50	20	
PA	3600	1.2-1.6	1-5	Foliar	25-50	Bacterial leaf spot,Anthrac.	0-25	10	Copper
RI	100	0.8-2.4	8	Foliar	100	Bacterial spot			Copper
SC	200	0.4-0.6	10-12	Foliar	10-20	Cercospora, Anthracnose	20-30	20	Copper
TN	3000	1.2-1.6	2-3	Foliar	60-80	Anthrac.,bact.spot,Cercospora	50	60	Fixed copper
VA	500	1.6	4-6	Foliar	100	Altern.,Anthrac.,Phoma	10	10	
VT	40	1.2-1.6	8	Foliar	100	Bacterial leaf spot,Anthrac.	80	60	Copper
WI	700	1.2-1.6	3-4	Foliar	20	Bacterial spot	20	10	Copper
Total	63605								
Average					72.6		46.2		

Table 45

PEPPER - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres Treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA	1.0	1	Pl.bed drench		Rhizoctonia, Pythium	50	50	
MD								
ME								
MI								
NC	1.5	1	Foliar	5	Leaf spot	20	10	EBDC, copper
	40	1	Pl.bed drench	20	Damping-off	20	10	Fumigation
NJ	0.25	1	Pl.bed drench					
NY								
OH			Treated seed	90-100	Damping-off			Thiram, metalaxyl
PA	2.25 oz/Cwt.	1	Seed trmt.	50	Damping-off	0-10	10	Thiram
	0.25 lb/100 gal	2	bed drench	50	Seed rot	0-10	10	Metalaxyl
RI			Treated seed	100	Seed decay			
SC								
TN								
VA								
VT	0.25	1	Pl.bed drench					
WI								

PUMPKIN

There are several important diseases of pumpkins which require fungicide applications for control. For many years, growers in most production areas would only apply 1-2 applications/season, because the crop value was not high. However, in recent years, there has been an increased consumer demand for pumpkins. In order to insure an adequate supply of pumpkins to meet consumer needs, growers have had to increase the number of fungicide applications to produce a satisfactory yield. The major diseases of pumpkins include powdery mildew (Erysiphe cichoacearum and Sphacrotheca fuliginea), downy mildew (Pseudoperonospora cubensis), and black rot (Didymella bryoniae). EBDC fungicides and chlorothalonil are the predominant fungicides used for control. When powdery mildew is severe, triadimefon is added to spray mixture. However, triadimefon is weak on Sphaerotheca and chlorothalonil is added to help provide control. When downy mildew is present, metalaxyl/EBDC or metalaxyl/chlorothalonil prepack mixture are used. Metalaxyl is highly effective against downy mildew; however, in order to prevent fungal resistance, metalaxyl can only be applied as a mixture with either EBDC or chlorothalonil. Benomyl is added with either EBDC or chlorothalonil to provide control of black rot. There are no disease-resistant varieties available for all diseases on pumpkins.

Table 46

PUMPKIN - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	400	1.6	2-4	Foliar		Mildew, stem blight			Chlorothalonil
DE	200		3-4	Foliar	50	Downy mildew, leaf blight			Chlorothalonil
FL	400	1.6-2.4	8	Foliar	95-100	Downy & powd.mild.,gummy stem			Dinocap, chlorothalonil
GA									
Il	6000	2.0	3-5	Foliar	20	Anthracnose,black rot,PM,DM	5-30	5	Chlorothalonil, benomyl
IN	1500	2.4	2-3	Foliar	40-60	Black rot	10-30	5	Chlorothalonil
KY	10	1.6	2	Foliar	5	Black rot, leaf spots	20	5	Chlorothalonil, benomyl
MA	2000	1.0	1	Foliar	25	Black rot, leaf spot, d.mildew	10	2	Copper sulfate
MD	700	2.4	5-6	Foliar	50	Scab, black rot	20-30	5	Fixed copper, chlorothalonil
ME	50	2.0	2	Foliar	50	PM,DM,Anthr,anf.lf.spot,bl.rot	10	5	Chlorothalonil, triadimefon, dinocap
MI	2000	1.6	8-9	Foliar	95	Anthrac.,Altern.,black rot	45	5	Chlorothalonil
NC	2500	1.2-1.6	4-9	Foliar	15	Leaf spots	40	5	Metalaxyl, copper, sulfur, triadimefon, chlorothalonil
NJ	250	1.2-2.4	4	Foliar	50	Black rot,leaf spots,d.mildew	80	10	Chlorothalonil, benomyl, thiophanate-methyl
NY	800								
OH	2500	2.4	5-6	Foliar	100	Anthrac.,DM,gum.stem,p.mildew	75-100	10	Thiophanate-methyl, chlorothalonil, benomyl
PA	3200	2.4	1.5	Foliar	5	Downy mildew	25		Metalaxyl, chlorothalonil
RI									
SC	200	0.8	10-12	Foliar	30+	Downy mildew, angular leaf spot	50-60	5	Chlorothalonil
TN	1600	1.6	1-5	Foliar	70	Downy mild.,scab,gummy stem	50	5	Chlorothalonil
VA	300	2.4	2	Foliar	50	Anthracnose, black rot		5	Chlorothalonil
VT	160	1.2-2.4	4	Foliar	50	Black rot, downy mildew	80	10	Chlorothalonil
WI	500	1.2-1.6	4-6	Foliar	50	Black rot	10	5	Chlorothalonil
Total	25270								
Average					48.6		35.5	6.1	

Table 47

PUMPKIN - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT	1.5-2.5	2-4	Foliar		Mildew, stem blight			EBDC
DE				50				EBDC
FL	1.2-2.25	8	Foliar	95-100	Downy & powd.mild.,gummy stem	100		EBDC
GA								
IL	1.5	3-5	Foliar	60	Anthr.,black rot,downy mildew	5-30	7	EBDC, benomyl, metalaxyl, thiophanate-methyl
IN	1.5	2-3	Foliar	40-60	Black rot	10-30	7	EBDC
KY	1.2	2	Foliar	5	Black rot, leaf spot	20	7	EBDC, benomyl
MA	1.6	1	Foliar	25	Anthracnose, scab,gummy stem	10	5	EBDC
MD	2.25	5-6	Foliar	50	Downy & powd.mild.,scab,bl.rot	20-30	7	EBDC, copper
ME								
MI	1.1	8-9	Foliar	95	Anthrac.,Altern.,black rot			EBDC
NC	1.12-1.5	4-9	Foliar	15	Leaf spots	40	10	EBDC, copper, metalaxyl, triadimefon
NJ	1.1-2.2	4	Foliar	25	Downy mildew,scab,black rot	80	20	EBDC, benomyl, thiophanate-methyl
NY	0.8-1.6	2-4	Foliar	80	D.mild.,p.mild.,scab,gum.stem	50-75	20	EBDC
OH	2.25	6-8	Foliar	100	Anthr.,DM,gum.stem,powd.mildew	75-100	20	Benomyl, triadimefon, dinocap, metalaxyl
PA	1.1-2.2	1-5	Foliar	50	Black rot,powdery mildew	25	10	Benomyl, thiophanate-methyl
RI								
SC	0.8-1.6	10-12	Foliar	20+	DM,Anthr.,Cercosp.,gum.stem	50-60	10	EBDC
TN	1.1-2.3	1-5	Foliar	10	Scab,downy mild.,gummy stem	50	10	EBDC
VA	1.13-2.25	2	Foliar	50	Downy mild.,Anthrac.,bl.rot	20	10	EBDC
VT	1.1-2.2	4	Foliar	25	Downy mildew,scab,black rot	80	20	EBDC, benomyl, thiophanate-methyl
WI	1.5	4-6	Foliar	50	Black rot	10	7	EBDC
Average				48.3		43.9	11	

Table 48

PUMPKIN - BENOMYL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o benomyl	Other Chemicals
CT	0.13-0.25	2-4	Foliar		Mildew, stem blight			
DE								
FL	0.125-0.25	8	Foliar	95-100	Powdery mildew			Dinocap
GA								
IL	0.5	1-3	Foliar	25	Anthrac.,black rot,powd.mild.			Chlorothalonil, triadimefon
IN	0.5	2-5	Foliar	60-80	Powdery mildew	10-20	2	Triadimefon
KY	0.25	2	Foliar	5	Black rot, leaf spots	20	5	EBDC, chlorothalonil
MA	0.25	2	Foliar	25	Powdery mildew			Triadimefon, dinocap
MD	0.25	5-6	Foliar	50	Black rot	30	20	Copper
ME	0.25	1	Foliar	50	Black rot	10		
MI	0.25	4-5	Foliar	60	Powdery mildew	20	2	Triadimefon
NC	0.12-0.25	4-9	Foliar	15	Leaf spots	40	5	Chlorothalonil, triadimefon, copper
NJ	0.13-0.25	4	Foliar	50	Black rot	20	5	Chlorothalonil, EBDC, thiophanate-methyl
NY	0.13-0.25	2-4	Foliar	40	Powd.mild.,bl.rot,gummy stem	30-50	5	Chlorothalonil, triadimefon
OH	0.25	4	Foliar	50	Powdery mildew	15-25	2	Dinocap, triadimefon, thiophanate-methyl
PA	0.125-0.25	1-5	Foliar	50	Black rot, powdery mildew	25	5	Chlorothalonil, thiophanate-methyl
RI								
SC	0.25	6-9	Foliar	30	Powdery mildew	20+	5	
TN								
VA	0.25-0.5	2	Foliar	50	Black rot, powdery mildew			Chlorothalonil, triadimefon
VT	0.13-0.25	4	Foliar	50	Black rot	20	5	Chlorothalonil, EBDC, thiophanate-methyl
WI								
Average				45.6		23.3	5.4	

Table 49

PUMPKIN - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL	2.0	3-5	Foliar	20	Anthracnose,black rot,PM,DM	5-30	2	Chlorothalonil, benomyl
IN								
KY								
MA								
MD								
ME								
MI								
NC								
NJ			Seed trmt.					
NY								
OH			Treated seed	90	Damping-off	25-50	5	Metalaxyl, thiram
PA	1.5 oz/Cwt.	1	Seed trmt.	50	Damping-off, seed rot	5	2	Thiram
RI								
SC								
TN								
VA								
VT			Seed trmt.					
WI								

SPINACH

There are several important diseases of spinach which can render an entire field unmarketable. Since only the leaves are harvested, leaf spots reduce the quality of crop and infested fields are abandoned. The major leaf diseases of spinach are blue mold (Peronospora effusa) and white rust (Albugo occidentalis). There are several varieties which possess resistance to both races of the blue mold pathogen; however, in most production areas, white rust is present. Only a few spinach varieties possess resistance to both diseases and these varieties are not adapted to all production areas. Other leaf diseases of spinach include anthracnose (Colletotrichum spinaciae and C. spinacicola) and Cladosporium leaf spot (Cladosporium macrocarbum). The latter diseases are generally only a problem on second or third cuttings (harvests) or on overwintered (fall planted-spring harvested) fields. EBDC fungicides (maneb) are the major fungicides used on spinach. The only alternative fungicide is tribasic copper sulfate and there is the potential for phytotoxicity with copper fungicides particularly during hot weather. The recent cancellation of maneb on spinach will severely restrict control options available to spinach growers in most production areas.

Captan is used as a seed treatment and plant bed drench for control of damping-off caused by several soil-borne fungi.

Table 50

SPINACH - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	70	1.2	1-2	Foliar		Downy mildew, rust			
DE	200		2-3	Foliar	25	Leaf spot,wh.rust,downy mildew			Metalaxyl
FL	100	1.2-1.6	4-6	Foliar	100	Downy mildew, white rust	10-50	40	Tribasic copper
GA									
IL	600	1.5	3-4	Foliar		White rust, downy mildew	5-50	30	Copper
IN									
KY	2								Comments: N/A
MA	200								Comments: none recommended
MD	2200	1.2	3-4	Foliar	50	Anthrac.,down.mild.,wh.rust	30	25	Metalaxyl
ME	15								Comments: none
MI	500	1.6	7-8	Foliar	95	Anthracnose, Cercospora	30	25	Copper
NC	50	1.2-1.6	2-4	Foliar	25	Leaf spots			Metalaxyl, copper
NJ	3500	1.2-1.6	3	Foliar	90	Clad.,b.mld,w.rst,lf.spt,Anthr.	45	40	Copper
NY	300								
OH	-								
PA	300	0.8-2.4	1-4	Foliar	80	Downy mildew	0-90	50	Metalaxyl
RI									
SC	400	1.2	5-6	Foliar	75	Downy mildew, white rust	50-80	60	
TN	1900	1.6	2-4	Foliar	95	Wh.rust,downy mild.,Cercospora	60	50	Copper
VA	800	1.2	2-4	Foliar	100	Downy mildew, white rust	30		Copper, metalaxyl
VT	45	1.2-1.6	3	Foliar	90	Clado.lf.spt.b.mld,w.rst,Anthr	45	35	Copper
WI	500								Comments: none
Total	11682								
Average					75.0		40.8		

Table 51

SPINACH - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA								
MD	2.5-3.5	1	Soil trmt/plant	10-20	Damping-off	30	25	Metalaxyl
ME								
MI								
NC	1.0	2-4	Foliar	25	Leaf spots			Metalaxyl, EBDC, sulfur
NJ	3.5	1	Plant bed	10	Damping-off	5	5	
NY								
OH								
PA	4.5 oz/Cwt.	1	Seed trmt.	50	Damping-off, root rot	0-20	10	Thiram
RI								
SC								
TN								
VA								
VT	3.5	1	Plant bed	10	Damping-off	5		
Average:				25.0		15	13.3	

SQUASH

The squash grouping includes summer squash and winter squash. Summer squash only require 40-50 days from planting to maturity; whereas, winter squash generally takes from 90-110 days from planting to harvest. Fungicides are needed for both crops. Summer squash requires disease-free plants to insure high quality and maximum yields. Winter squash disease control program is designed not only to produce maximum yield, but also to insure disease-free fruit at harvest because the majority of the crop is stored for a period of 4-6 months prior to marketing. Only high quality fruit can be stored without developing postharvest losses.

The primary diseases present on squash are powdery mildew (Erysiphe cichoracearum and Sphaerotheca fuliginea), downy mildew (Pseudoperonospora cubensis), scab (Cladosporium cucumeriunum), Alternaria leaf spot (Alternaria cucumerina), and black rot (Didymella bryoniae). EBDC fungicides and chlorothalonil are the predominantly used fungicides for control. When powdery mildew is severe, triadimefon is added with chlorothalonil to enhance control. Triadimefon is particularly effective against Erysiphe sp., but only marginally effective against Sphaerotheca. Sphaerotheca is the predominant genus present in the Eastern U.S. During seasons of high downy mildew incidence, metalaxyl/EBDC and metalaxyl/chlorothalonil prepack mixtures are applied. Metalaxyl is highly effective against downy mildew; however, to prevent pathogen resistance to metalaxyl, metalaxyl can only be applied as a mixture with either EBDC fungicides or chlorothalonil. Benomyl is added to the disease program to assist in control of scab and black rot.

There are no disease-resistant varieties of squash for the above diseases. Frequency and type of fungicide used depends each season on the environmental conditions and the incidence of specific diseases.

Captan is applied as a seed treatment for the prevention of seed decay and damping-off. Damping-off is responsible for poor stands and control is necessary.

Table 52

SQUASH, SUMMER & WINTER - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	600	1-2	4-10	Foliar	95	Leaf blight, mildews			Chlorothalonil
DE	800		4-5	Foliar	5-10	Downy mildew,scab			Chlorothalonil
FL	16000	1.6-2.4	5	Foliar	95-100	Downy mildew, fruit rots			Dinocap, chlorothalonil
GA	7500	1.6-2.4	5	Foliar	95	Downy mildew, fruit rots	45	5	Chlorothalonil
IL	600	1.5	2-4	Foliar	10	Anthracnose, powdery mildew	5-30	2	Chlorothalonil, benomyl
IN									
KY	550	1.6	2	Foliar	20	Alter.,Anthr.,p.mild.,gum.stem			Chlorothalonil
MA	2500	1.0	2	Foliar	75	Bl.rot,Alter.,scab,ang.lf.spot	25	5	Fixed copper, chlorothalonil
MD	500	2.4	5-6	Foliar	50	Downy mildew,scab,black rot	20-30	5	Fixed copper, chlorothalonil
ME	115	2.0	2	Foliar	50	P.mild.,d.mild.,Anthr.,bl.rot	10	2	Chlorothalonil, triadimefon, dinocap
MI	2000	1.6	8-9	Foliar	95	Anthracnose,Altern.,black rot	45	5	Chlorothalonil
NC	5200	1.2-1.6	4-6	Foliar	35	Leaf spots	50	5	Copper, anilazine, metalaxyl, sulfur, chlorothalonil
NJ	1750	1.2-2.4	2	Foliar	20-50	Scab,downy mildew,powd.mildew	30-80	5	Chlorothalonil, benomyl, thiophanate-methyl
NY	1700								
OH	500	2.4	5-6	Foliar	90-100	Downy mild.,Anthrac.,gum.stem	75	5	Chlorothalonil, benomyl
PA	4300	2.4	1-5	Foliar	5	Downy mildew	25	2	Metalaxyl, chlorothalonil
RI									
SC	1000	1.5-2.25	6-7	Foliar	10-30	Downy mildew	30-50	5	Chlorothalonil
TN	1100	1.6	2-4	Foliar	40	Downy mildew,scab,Anthracnose	30	5	Chlorothalonil
VA	350	2.4	2-4	Foliar	50	Downy mildew, powdery mildew	20	5	Metalaxyl, triadimefon, chlorothalonil
VT	200	1.2-2.4	2	Foliar	20-50	Scab, downy mildew, powd. mildew	30-70	5	Chlorothalonil, benomyl, thiophanate-methyl
WI	500	None							
Total	47765								
Average					53.3		34.6		

Table 53

SQUASH, SUMMER & WINTER - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT	1-2	4-10	Foliar	90	Leaf blight, mildews			EBDC, copper, triadimefon
DE		4-6	Foliar	90	Scab, downy mildew			EBDC
FL	1.5-2.2	5	Foliar	95-100	Downy mildew, fruit rots			EBDC
GA	1.5-2.2	5	Foliar	95	Downy mildew, fruit rots	45	20	EBDC
IL	2.0	2-4	Foliar	10	Anthracnose, powdery mildew	5-30	15	EBDC, benomyl
IN								
KY	2.0	2	Foliar	20	Alter.,Anthr.,p.mild.,gum.stem			EBDC
MA	1.6	2	Foliar	75	Anthracnose,scab,gummy stem	25	15	EBDC
MD	2.25	5-6	Foliar	50	Downy mildew,scab,black rot	20-30	20	EBDC
ME								
MI	1.1	8-9	Foliar	95	Anthracnose,Altern.,black rot			EBDC
NC	1.1-1.5	4-6	Foliar	20	Leaf spots	50	25	EBDC, copper, anilazine, metalaxyl, sulfur
NJ	1.1-2.2	2-4	Foliar	20-50	Downy mildew,scab,powd.mild	30-80	25	EBDC, metalaxyl/EBDC, benomyl, thiophanate-methyl
NY	0.8-1.6	2-4	Foliar	80-100	Downy & powd.mild.,gummy stem	50-60	30	EBDC
OH	2.25	6-8	Foliar	100	Anthrac.,downy mild.,gum.stem	75	30	EBDC, thiophanate-methyl, metalaxyl
PA	1.1-2.2	1-5	Foliar	50	Black rot, powdery mildew	25	10	Benomyl, thiophanate-methyl
RI								
SC	1.13-1.5	6-7	Foliar	5-10	Downy mildew	30-50	45	EBDC
TN	1.1-2.3	2-4	Foliar	40	Downy mildew,scab,Anthrac.	30	20	EBDC
VA	1.13-2.25	2-4	Foliar	50	Downy & powd.mild.,Phytophth.	20	15	EBDC, metalaxyl/chlorothalonil or metalaxyl/EBDC
VT	1.1-2.2	2-4	Foliar	20-50	Downy mildew,scab,powd.mildew	30-80	25	EBDC, metalaxyl/EBDC, benomyl, thiophanate-methyl
WI								
Average				60.8		39.0		

Table 54

SQUASH, SUMMER & WINTER - BENOMYL

State	Rates lb ai/A	No Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o benomyl	Other Chemicals
CT	0.12-0.25	2-6	Foliar		Powdery mildew,black rot			Triadimefon
DE								
FL	0.12-0.25	5	Foliar	95-100	Powdery mildew			Dinocap
GA	0.12-0.25	5	Foliar	95	Powdery mildew	20	15	Dinocap
IL	0.5	1-3	Foliar	10	Anthracnose, powdery mildew	5-30	10	EBDC, chlorothalonil
IN								
KY	0.25	2	Foliar	20	Alternaria, Anthracnose,powd.			Mildew, gummy stem
MA	0.25	2	Foliar	50	Powdery mildew			
MD	0.25	5-6	Foliar	50	Black rot	20-30	20	Copper
ME	0.25	1	Foliar	50	Bl.rot,Anthr.,d.mild.,p.mild.	10	5	EBDC
MI	0.25	4-5	Foliar	60	Powdery mildew	20	5	Triadimefon
NC	0.12-0.25	4-6	Foliar	20	Leaf spots	50	10	EBDC, copper, chlorothalonil
NJ	0.125-0.25	2-4	Foliar	20	Scab, black rot	20	5	Chlorothalonil, EBDC, thiophanate-methyl
NY	0.13-0.25	2-4	Foliar	40	Powd.mild.,bl.rot,gummy stem	30-50	10	Chlorothalonil, triadimefon
OH	0.25	3-4	Foliar	50	Powdery mildew	15-25	5	Triadimefon, thiophanate-methyl, dinocap
PA	0.12-0.25	1-5		25	Black rot, powdery mildew	25	5	Chlorothalonil, thiophanate-methyl
RI								
SC	0.12-0.25	3-4	Foliar	20	Powdery mildew	10-20	5	
TN								
VA								
VT	0.125-0.25	2-4	Foliar	20	Scab, black rot	20	5	Chlorothalonil, EBDC, thiophanate-methyl
WI								
Average				42.0		23.5		

Table 55

SQUASH, SUMMER & WINTER - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL								
IN								
KY								
MA								
MD								
ME								
MI								
NC								
NJ			Seed trmt.					
NY								
OH			Treated seed	90-100	Damping-off	25	5	Metalaxyl, thiram
PA	1.5 oz/Cwt.	1	Seed trmt.	50	Damping-off, seed rot	5	5	Thiram
RI								
SC								
TN								
VA								
VT			Seed trmt.					
WI								

SWEET CORN

The major diseases of sweet corn include rust (*Puccinia sorghi* and *P. polysora*), southern corn leaf blight (*Helminthosporium maydis*), and northern corn leaf blight (*Helminthosporium turcicum*). Some varieties possess resistance to rust or leaf blights, but none possess resistance to both rust and leaf blights. Additionally, resistant varieties do not possess the characteristics to meet market demands and processor needs, and as a result, they are not widely grown.

In production areas of the mid-Atlantic and northeastern United States, few fungicide applications are warranted, because the majority of the crop is produced prior to favorable environmental conditions for disease (late summer and early fall). However, in the southeastern United States, favorable environmental conditions exist during the entire production period in most years. Consequently, more fungicide applications are required in the southern production areas.

EBDC fungicides and chlorothalonil are the predominantly used fungicides for sweet corn foliar diseases. Captan is used as a seed treatment to prevent seed decay which can result in poor stands if not controlled.

Table 56

SWEET CORN - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	8000	1.6	1-2	Foliar	5-10	Rust			
DE	7000								
FL	52000	1.6	1-15	Foliar	95-100	Rust,south&north.leaf blight	5-50	5	Chlorothalonil
GA	7000	1.6	10-15	Foliar	95	Rust,south.&north.leaf blight	40	5	Chlorothalonil
IL	35000	1.5	2-4	Foliar	15	Rust,north.corn leaf blight	5-30	5	Chlorothalonil
IN									
KY	800		1	Seed trmt.	35	Damping-off			
MA	10000	1.0	1	Foliar	2	Rust	3	1	Chlorothalonil
MD	17000	1.2-2.0	3-4	Foliar	<10	Leaf blights	10-15	5	Chlorothalonil
ME	1500								
MI	12000	1.2	3-4	Foliar	75	Rust,Helmin.,leaf spot	25	5	Chlorothalonil
NC	11500	1.2	4	Foliar	5	Rust, leaf spots	10	2	Chlorothalonil
NJ	11300	1.2	2	Foliar	2	Leaf blight	1-5	<1	Chlorothalonil
NY	60000	1.2	1-3	Foliar	5-15	Rust,northern leaf blight	10-20	5	Chlorothalonil
OH	15000	1.2	2-3	Foliar	50	Rust,Helmin. leaf spot	15-20	5	Chlorothalonil
PA	23000	1.2	1-4	Foliar	10	Rust, leaf spot	2	1	Chlorothalonil
RI									
SC	910	1.2	2	Foliar	20-30	Rust,South. corn leaf blight	20-90	5	Chlorothalonil
TN	1500	1.6	2-3	Foliar	5	Leaf blight, rust	1		Chlorothalonil
VA	1000								
VT	2000	1.2	2	Foliar	2	Leaf blight	1-5	<1	Chlorothalonil
WI	200000	1.5	2-4	Foliar	10	Rust	20		
Total	476510								
Average					27.7		16.2		

Table 57

SWEET CORN - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT								
DE								
FL	1.5	1-15	Foliar	95-100	Rust,south.&north.leaf blight	5-50	5	EBDC
GA	1.5	10-15	Foliar	90	Rust,south.&north.leaf blight	40	15	EBDC
IL	1.5	2-4	Foliar	15	Rust,north.corn leaf blight	5-30	5	EBDC
IN								
KY								
MA	1.5	1	Foliar	2	Rust	3	1	EBDC
MD	0.75	3-4	Foliar	<10	Rust	10-15	5	EBDC
ME								
MI	1.1	3-4	Foliar	75	Rust,Helmin.,leaf spot	25	5	EBDC
NC	1.1-1.5	4	Foliar	5	Rust, leaf spots	10	2	EBDC
NJ	0.6-1.5	2-4	Foliar	2-5	Rust, leaf blight	1-5	<1	EBDC
NY	0.54-1.1	1-2	Foliar	1-3	Rust,northern leaf blight	10-20	5	EBDC
OH	1.5	2-3	Foliar	50	Rust, Helmin. leaf spot	15-20	5	EBDC
PA	0.6-1.5	1-4	Foliar	10	Rust, leaf spots	2	1	EBDC
RI								
SC	1.13-1.5	2	Foliar	10	South.corn leaf blight, rust	20-90	5	EBDC
TN								
VA								
VT	0.6-1.5	2-4	Foliar	2-5	Rust, leaf blight	1-5	<1	EBDC
Average				28.9		17.8		

Table 58

SWEET CORN - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT		1	Seed trmt	90	Seed decay			
DE								
FL								
GA								
IL								
IN								
KY		1	Seed trmt	35	Damping-off			
MA								
MD								
ME								
MI								
NC								
NJ								
NY								
OH			Treated seed	90-100	Damping-off	25	2	Thiram
PA	1.5-1.9 oz/Cwt.	1	Seed trmt.	50	Seed rot	15	2	Thiram, metalaxyl
RI								
SC								
TN								
VA								
VT			Treated seed	100	Damping-off	10		

SWEET POTATO

The only diseases of sweet potato which require the use of a fungicide are those involved with transplant production and postharvest. No fungicides are applied to the foliage of sweet potatoes. The primary diseases of sweet potatoes include black rot (Ceratostomella fimbriata), scurf (Monilochaetes infuscans) and soft rot (Rhizopus stolonifer).

Dicloran and thiabendazole are used as a prebed dip or spray prior to transplant production or a postharvest dip or spray for prevention of diseases. However, if proper curing and storage conditions are achieved after harvest, fungicides are not used at harvest. Rather, fungicides generally are used prior to marketing to prevent diseases in transit. Any injury resulting from handling during the packing operation predisposes sweet potatoes to decay prior to their final destination, and a fungicide is needed for prevention.

Table 59

SWEET POTATO

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss	Other Chemicals
CT	0							
DE	0							
FL								
GA	6000							
IL	0							
IN								
KY	3							
MA								
MD	800							
ME	10							
MI	0							
NC	3400							
NJ	2500							
NY								
OH	25							
PA	100							
RI								
SC	4000							
TN	1500							
VA	1000							
VT	0							
WI	20							
Total	19358							

TOMATO

Tomatoes are grown either for the fresh market or for processing purposes. For fresh market production, the major diseases are foliage diseases because the crop is harvested prior to full fruit maturity. Processing tomatoes are harvested after the majority of fruit are mature; consequently, both foliar and fruit diseases need to be controlled.

The primary foliar diseases of tomato are early blight (Alternaria solani), Septoria leaf spot (Septoria lycopersici), gray leaf spot (Stemphylium solani), bacterial speck (Pseudomonas syringae pv. tomato), bacterial spot (Xanthomonas vesicatoria), and late blight (Phytophthora infestans). Anthracnose (Colletotrichum coccodes) is the major fruit rot of tomatoes. There are several other fruit rots of tomatoes which are only sporadic in importance and are generally controlled with normal fungicide spray programs for foliar diseases.

The major fungicides used for foliar disease control in tomatoes are EBDC fungicides and chlorothalonil. Normally 6-8 applications are required for control. In some states in the region, forecasting systems are in place to predict the onset of early blight and spray intervals are predicted based on environmental conditions. For the control of bacterial leaf spots, seed are treated with chlorine; copper plus EBDC fungicides are applied during transplant and field production. There are no commercial varieties with resistance to foliar diseases of tomatoes.

Chlorothalonil is the only fungicide which provides acceptable control of anthracnose fruit rot. Fungicide schedules usually involve EBDC fungicides early in the season for foliar disease control followed by applications of chlorothalonil at the end of the season. Recently a prepack mixture of chlorothalonil, a copper fungicide, and maneb, an EBDC, has been used quite effectively for control of both fungal and bacterial leaf spots and anthracnose fruit rot. Without the use of EBDC fungicides in combination with copper fungicides, bacterial leaf spot control would not be possible. EBDC fungicides synergize copper fungicides making them more effective. Also, bacterial leaf spot pathogens in many production areas are resistant to copper fungicides.

Benomyl is used to control Botrytis gray mold and ghost spot (Botrytis cinerea) in greenhouse production. Also benomyl is applied in field production to assist in control of leaf spots and benomyl is applied twice alone early in the season to provide control of timber rot (Sclerotinia sclerotiorum). There are no alternatives to benomyl for the control of timber rot.

Captan is used as a seed treatment and a plant bed drench to control seed decay and damping-off caused by soil-borne fungi. Control of damping-off is essential to insure adequate plant stands.

Table 60
TOMATO - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	600	1.2	4-7	Foliar	90	Leaf spots	50	5	Chlorothalonil, metalaxyl, copper
DE	700		4-5	Foliar	25	Bacterial spot, leaf spots			Copper, chlorothalonil
FL	46000	1.2	24	Foliar	100	Ea.blight,late bl.,bact spot	20-100	20	Chlorothalonil
GA	3300	1.2	10	Foliar	100	Early blight, bacterial spot	50	20	Chlorothalonil
IL	2500	2.0	3-5	Foliar	60	Alter.,Septo.,Anthr.,bact.spk.	10-80	5	Chlorothalonil, copper
IN	7500	2.4	4-10	Foliar	100	Ea.blight, Septoria, Anthracnose	20-60	5	Chlorothalonil, coppers
KY	1600	2.4	7	Foliar	95	Early blight, buckeye	50	5	Anilazine, chlorothalonil
MA	800	1.0	6	Foliar	100	Ea&late bl.,Botry.,Stemph.,Anthrac.	75	7	Metalaxyl/EBDC, chlorothalonil
MD	4500	2.4	6-8	Foliar	90	Leaf spot, fruit rot	20-30	5	Fixed copper, chlorothalonil
ME	90	2.0	3-4	Foliar	70	Leaf spot, fruit rot			Metalaxyl, chlorothalonil
MI	11000	2.0	8-9	Foliar	95	Alternaria, Anthracnose	60	7	Chlorothalonil
NC	2000	0.8	18-22	Foliar	45	Leaf spots, blights	60	10	Copper, anilazine, metalaxyl, chlorothalonil
NJ	9000	1.12-2.25	4-7	Foliar	100	Fung.lf.spots,bact.lf.spots	75	20	Chlorothalonil, anilazine
NY	4100	0.8-2.4	2-6	Foliar	100	Leaf spots, fruit rots	50-75	10	Anilazine, chlorothalonil
OH	21000	2.4	3-12	Foliar	100	Early blight, Anthracnose	80	15	Anilazine, fixed copper, chlorothalonil
PA	10500	2.4	3-10	Foliar	45	Leaf spot, fruit rot	50	10	Anilazine, ziram, chlorothalonil
RI	200	1.2-2.4	3	Foliar	100	Early blight, Anthracnose			Chlorothalonil
SC	3700	1.2-2.4	9	Foliar	80	Ea&lt.bl.gry.lfspt.&mold,Anthr.	50-100	10	Copper, metalaxyl/chlorothalonil, chlorothalonil
TN	4400	1.6	9-18	Foliar	85	Early blight, Septoria,bact.	100	50	Fixed copper, anilazine, chlorothalonil
VA	4500	2.4	4-8	Foliar	100	Leaf spots fruit rots	40	10	Chlorothalonil
VT	85	1.12-2.25	4-7	Foliar	100	Fung.lf.spots,bact.lf.spots	75	20	Chlorothalonil,anilazine
WI	500	1.2-1.6	6-10	Foliar	100	Ea.blight,Septoria,Anthrac.	25	10	Chlorothalonil
Total	138575								
Average					85.4		47.8		

Table 61

TOMATO - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT	1.0	4-7	Foliar	90	Leaf spots			EBDC
DE		5-10	Foliar	75	Leaf spots			EBDC
FL	1.5-2.2	5	Foliar	50	Ea. & late blight,target spot	20-100	15	EBDC
GA	1.5-2.2	5	Foliar	40	Early blight	50	15	EBDC
IL	1.5	3-5	Foliar	90	Asst. leaf spots	10-80	10	EBDC,copper
IN	1.5	4-10	Foliar	100	Ea.blight,Septoria,Anthracnose	20-60	10	Coppers
KY	1.5	7	Foliar	95	Ea.blight, buckeye	50	10	Anilazine, EBDC
MA	1.8	6	Foliar	100	Ea&lt bl.Botryt.Stemph.Anthr.	75	15	EBDC
MD	2.25	6-8	Foliar	90	Leaf spots,fruit rots	20-30	10	EBDC
ME	0.5	3-4	Foliar	70	Leaf spots, fruit rots			EBDC
MI	1.8	8-9	Foliar	95	Alternaria, Anthracnose	60	10	EBDC
NC	1.5	18-22	Foliar	40	Leaf spots, blights	60	15	EBDC, copper anilazine, metalaxyl
NJ	1.5-2.2	4-7	Foliar	100	Leaf spots, Anthracnose	75	75	EBDC, anilazine
NY	1.1-2.2	2-6	Foliar	100	Leaf spots, fruit rots	50-75	45	EBDC, anilazine
OH	1.5-2.0	5-12	Foliar	100	Early blight, Anthracnose	80	50	EBDC, anilazine, fixed copper
PA	1.1-2.2	3-10	Foliar	45	Leaf spots, fruit rots	50	40	EBDC,ziram,anilazine
RI	0.9	4-7	Foliar	100	Early blight, Anthracnose			EBDC
SC	0.81-1.08	9	Foliar	15	Ea&lt bl.,gray lf.spot,Septoria	50-100	30	EBDC, metalaxyl/chlorothalonil
TN	1.3	9-18	Foliar	10	Leaf spots, fruit rots	100	30	EBDC, anilazine, fixed copper
VA	1.5-2.3	2-6	Foliar	100	Leaf spots, fruit rots	40	30	EBDC
VT	1.5-2.2	4-7	Foliar	100	Leaf spots, Anthracnose	75	50	EBDC, anilazine
WI	1.5	6-10	Foliar	100	Ea.blight,Anthrac.,Septoria	25	15	EBDC
Average:				77.5		51.5		

Table 62

TOMATO - BENOMYL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o benomyl	Other Chemicals
CT	0.25-0.5	2-6	Foliar	50-80	Leaf blights	50	5	Chlorothalonil
DE								
FL	0.25-0.5	2	Foliar	35	Sclerotinia	15	15	
GA	0.25-0.5	2	Foliar	15	Sclerotinia	5	5	
IL	0.5	2-4	Foliar	30	Botrytis	10-80	10	EBDC, chlorothalonil
IN								
KY								
MA	0.25	6	Foliar	10	Sclerotinia	5	5	
MD	0.5	6-8	Foliar	15	Sclerotinia	10-15	10-15	
ME								
MI								
NC	0.5		Foliar	5	Leaf spots,blights	60	10	EBDC, chlorothalonil,copper, anilazine
NJ	0.25-0.5	2	Foliar	10	Sclerotinia	5	5	
NY	0.5	1-2	Foliar	5-10	Botrytis, Sclerotinia,Cladosp.	20	15	
OH	0.5	1.2	Foliar	75	Botrytis, Septoria	50	10	Chlorothalonil,anilazine
PA	0.25-0.5	3-10	Foliar	90	Botrytis, fruit rot	5	2	Chlorothalonil
RI	0.25-0.5	2	Foliar		Botrytis,leaf spot,white mold			
SC								
TN	0.25	5-10	Foliar	5	Botrytis	10	2	Chlorothalonil, anilazine
VA	0.25-0.5	2	Foliar	100	Sclerotinia	10	10	Thiophanate-methyl
VT	0.25-0.5	2	Foliar	10	Sclerotinia	5	5	
WI								
Average				35.0		21.2		

Table 63

TOMATO - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield losses w/o captan	Other Chemicals
CT								
DE								
FL								
GA								
IL	2.0-2.5	1-4	Foliar	10	Anthracnose, Septoria			Chlorothalonil, EBDC
IN								
KY								
MA								
MD								
ME								
MI								
NC								
NJ			Seed trmt.					
NY								
OH								
PA	1 lb/100gal	1	Soil appl.	25	Damping-off, root rot	10	5	Metalaxyl
RI								
SC								
TN		1	Pl.bed drench	10	Seedling disease	10	2	Methyl bromide
VA	2.1 oz/Cwt.	1	Seed trmt.	90-100	Damping-off	10	5	Thiram
VT			Seed trmt.					
WI								

WHITE POTATO

The major diseases of white potato which require fungicide use for control are Fusarium seed piece decay (Fusarium solani), early blight (Alternaria solani), and late blight (Phytophthora infestans). Since the crop is propagated from tubers, tubers must be protected from seed piece decay with fungicides at planting. Captan, EBDC fungicides, thiabendazole or thiophanate-methyl are used for control. Without seed piece protection, poor stands would result and yields would be greatly reduced.

For control of early and late blight, EBDC fungicides and chlorothalonil are the primary fungicides used. When late blight epidemics occur, metalaxyl/EBDC or metalaxyl/chlorothalonil prepack combinations are applied. Metalaxyl is highly effective against late blight but must be combined with an EBDC fungicide or chlorothalonil to prevent resistance from developing to metalaxyl by Phytophthora infestans. In a few production areas, disease forecasting systems are in place to schedule fungicide applications for late blight depending on environmental conditions.

Proposed cancellation of EBDC fungicides on white potatoes would severely affect potato production in the United States. In many production areas, EBDC fungicides are the sole fungicides used because they are the only economical fungicides available for white potatoes. Since white potatoes are a low value/acre crop, growers cannot afford to apply more expensive alternative fungicides and still make a profit. Therefore, the loss of EBDC fungicides would force many growers to stop growing potatoes, because they could not afford to grow them with alternative fungicides.

Table 64
WHITE POTATO - EBDC

State	No.acres planted	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o EBDC	Other Chemicals
CT	800	0.8 lb/Cwt	1	Seedpiece trmt	75	Seedpiece decay			Captan
DE	9000	5-7% dust	1	Seedpiece	100	Seed decay			
			6-8	Foliar	90-100	Early blight	10-20	10	Chlorothalonil
FL	35000	1.2	7-10	Foliar	100	Early blight, late blight	35	30	Metalaxyl, chlorothalonil
		1 Cwt		Seedpiece					
GA									
IL	600	2.0	2-5	Foliar	70	Early blight, late blight	5-80	5-80	Chlorothalonil, iprodione
IN	5000	2.4	2-6	Foliar	100	Early blight	10-30	5	Chlorothalonil, iprodione, coppers
KY	500	1 lb/Cwt.	1	Seedpiece trmt.					Captan
		1.6	3	Foliar	50	Early blight			Duter, chlorothalonil
MA	4000	1.5	7	Foliar	25	Early blight, late blight	60	5	Metalaxyl/chlorothalonil
MD	1000	0.56 lb/Cwt.	1	Seedpiece	50	Seedpiece decay			Super tin, Metalaxyl/chlorothalonil, Duter
		1.6	2-3	Foliar	75	Early blight, late blight	15-20	5	
ME	80000	1.6	10	Foliar	100	Early blight, late blight	50	5	Copper, tin, metalaxyl
MI	55000	0.8-1.6	4-10	Foliar	100	Early blight, late blight	50	5	Chlorothalonil, anilazine, metalaxyl/EBDC
NC	15800	1.2	1-5	Foliar	20	Early blight, late blight	10	2	Anilazine, copper, metalaxyl, chlorothalonil
		0.75-1.0/Cwt.	1	Seed trmt.	100	Fusarium			
NJ	8000	0.75-1.5	3	Foliar	100	Alternaria	5	2	Metalaxyl/chlorothalonil, triphenyltin hydroxide, chlorothalonil
NY		1.6	1	Seed trmt.	70	Seedpiece decay	10	2	Captan,
	33000	1.6	8	Foliar	100	Early blight,late blight	50	5	Metalaxyl, triphenyltin hydroxide, anilazine,iprodione, chlorothalonil
OH	10000	1.6	8-10	Foliar	100	Early blight, late blight	50	25	Metalaxyl, fixed copper, chlorothalonil
			1	Seedpiece		Seedpiece decay	20	5	Thiabendazole
PA	20000	2.4	4-8	Foliar	100	Early blight, late blight			Duter, Super Tin, chlorothalonil
RI	2000	1.2	3	Foliar	100	Early blight,late blight			Chlorothalonil
SC	210	1.13-1.15	10-12	Foliar	50	Ea.&late bl.,seedpiece decay	100	10	Chlorothalonil
TN	1000	1.6	3-8	Foliar	60	Early blight	20	5	Chlorothalonil
VA	12000	1.2-1.6	2-4	Foliar	50	Early bl.,Botry.,pink rot,leak	10	2	Chlorothalonil
		0.05-0.8	1	Seed trmt.	90	Fusarium	10	2	Captan

Table 64 - Continued

White Potato - EBDC

VT	300	0.75-1.5	3	Foliar	100	Alternaria	5	2	Metalaxyl/chlorothalonil, triphenyltin hydroxide, chlorothalonil
		0.75-1.0/Cwt	1	Seed trmt.	100	Fusarium			
WI		0.075/Cwt.	1	Seed trmt.	60	Seedpiece decay			Captan, fir bark
	62000	1.2-1.6	4-12	Foliar	100	Early blight, late blight	25	15	TPTH, chlorothalonil
Total	355210								
Average:					80.0		30.2	8.9	

Table 65

WHITE POTATO - CHLOROTHALONIL

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o chlorothalonil	Other Chemicals
CT	0.5-1.2	2-6		100	Early blight, late blight			EBDC, copper, metalaxyl/EBDC
DE								
FL	0.75-1.12	3	Foliar	60	Early blight, late blight			EBDC, metalaxyl
GA								
IL	1.5	2-5	Foliar	50	Early blight, late blight			EBDC, iprodione
IN	1.5	2-6	Foliar	100	Early blight	10-30	5	Iprodione, coppers
KY	1.5	3	Foliar	50	Early blight			EBDC
MA	1.8	6	Foliar	100	Early blight, late blight	60	5	EBDC, metalaxyl
MD	1.2	2-3	Foliar	75	Early blight, late blight	15-20	5	Copper, EBDC, Duter, Super tin
ME	0.25	10	Foliar	40	Early blight, late blight	50	5	EBDC, copper, tin, metalaxyl
MI								
NC	0.75-1.1	1-5	Foliar	10	Early blight, late blight	10	2	EBDC, anilazine, metalaxyl
NJ	2.25	3	Foliar	25	Alternaria	5	2	EBDC, triphenyltin hydroxide, metalaxyl/EBDC
NY	1.13	2	Foliar	20	Early & late blight, Botrytis	50	5	EBDC, iprodione
OH	1.12	8-10	Foliar	100	Early blight	50	5	EBDC
PA	2.25	4-8	Foliar	100	Early blight, late blight			EBDC, Suster, Super tin, metalaxyl (alone, +EBDC, +chloro)
RI	0.45-0.85	3	Foliar	100	Ea.blight, late blight, leak			EBDC
SC	0.54-0.81	10-12	Foliar	30	Ea.&late bl.,seedpiece decay	100	10	EBDC
TN	1.1	3-8	Foliar	5	Early blight	20	5	EBDC
VA	0.75-1.13	2-4	Foliar	50	Early bl.,Botry.,pink rot, leak	10	2	EBDC
VT	2.25	3	Foliar	25	Alternaria	5	2	EBDC, triphenyltin hydroxide, metalaxyl/EBDC
WI	0.75-1.13	4-12	Foliar	100	Early blight, late blight	25	5	Metalaxyl (+EBDC, +chlorothalonil), triphenyltin hydroxide
Average				60.0		30.6		

Table 66

WHITE POTATO - CAPTAN

State	Rates lb ai/A	No. Appl.	Method of applic.	% Acres treated	Target Diseases	% Yield loss w/o fungicides	% Yield loss w/o captan	Other Chemicals
CT	0.75 lb/Cwt.	1	Seedpiece trmt.	75	Seedpiece decay, scab			EBDC
DE								
FL								
GA								
IL	0.25/bu	1	Seedpiece trmt.	25	Fusarium	5-20	2	EBDC
IN								
KY	1.0/Cwt.	1	Seedpiece trmt.	50	Seedpiece decay			EBDC
MA								
MD	0.375 lb/Cwt.	1	Seedpiece trmt.	75	Seedpiece decay	15-20	5	Sulfur
ME								
MI								
NC	1 lb/Cwt.	1	Seedpiece trmt.	80		20	2	EBDC, thiabendazole
NJ	0.75-1.0/Cwt.	1	Seed trmt.	100	Fusarium			
NY								
OH	1.6	1	Seedpiece trmt.	75	Fusarium,Pythium,Rhizoctonia	20	5	Thiabendazole
PA								
RI	0.75/Cwt.	1	Seedpiece trmt.	100	Seedpiece decay			Thiabendazole
SC								
TN								
VA								
VT	0.75-1.0/Cwt.	1	Seed trmt.	100	Fusarium			
WI	0.075/Cwt.	1	Seedpiece trmt.	60	Seedpiece decay	10-20	5	EBDC, fir bark

III. CONCLUSIONS

Fungicide use is extremely beneficial to the production of vegetable crops in the eastern United States. Humid, wet environmental conditions of the region are conducive to disease development annually. In order to market vegetables, they must be of high quality (blemish-free). Additionally, costs of producing vegetables are escalating annually and prices received by the grower for vegetables have remained relatively low with no annual increases. As a result, in order for growers to continue to produce vegetables, they must be able to achieve maximum yields and high quality. The only method to achieve this goal is through the use of timely applications of fungicides.

There are a few other control measures which assist in control and, wherever possible, are integrated with fungicides within a disease management program. Disease-resistant varieties enable a reduction in the use of fungicides in some cases. The disease forecasting system assists growers to more effectively time fungicide applications. Cultural controls such as crop rotation and reduction of weed and insect pressures reduce stress and alter the microclimate surrounding the vegetable plant which, ultimately, reduces the rate and number of fungicide applications.

Vegetable disease control is greatly dependent on the availability of fungicides. Integrating fungicides with other control measures helps to maintain disease-free produce in the safest manner. Fungicide usage is extremely dependent on environmental conditions. During periods of dry weather, fungicide use is reduced. However, during periods when environmental conditions are favorable for disease development, fungicide use increases in order to protect the crop from disease. It would be impossible to grow vegetables without fungicides in areas where environmental conditions favor disease development (entire eastern United States).

The recent suspension of EBDC fungicides and potential cancellation of the majority of vegetable uses for EBDC fungicides by EPA will cause severe problems for vegetable production in the eastern United States. For some crops such as peppers there are no alternative fungicides. For other crops, the only alternative is copper fungicides. Copper fungicides cause phytotoxicity to some vegetables when used at full rates the entire season.

A major concern over the loss of EBDC fungicides is the lack of ability of vegetable growers to manage pathogen resistance to remaining fungicides. EBDC fungicides are a major component in disease resistance management. Newly registered vegetable fungicides are specific site inhibitors and need to be combined with a broad-spectrum, multisite inhibitor fungicide to prevent pathogen resistance.

IV. RECOMMENDATIONS

It is imperative that the majority of fungicide registrations be maintained on vegetables. Without fungicides, current quality and yield parameters of vegetables would be greatly reduced. Loss of quality and yield of vegetables would force growers to switch to other commodities. Ultimately, a severe shortage of vegetables produced in the United States would result.

Concerns over the safety of fungicides are exaggerated. In order to achieve the levels of fungicides which laboratory animals consumed in feeding studies where deleterious effects were observed, an individual human would have to consume several gallons of vegetable juice or tons of raw produce every day for 70 years. Clearly, daily human diet exposure levels are far below any deleterious effect level. The tremendous benefits of fungicide use to vegetables are far superior to the small risk of hazard to food safety from fungicide use.

One means of reducing fungicide use, such as the EBDC fungicides, would be to lengthen the days to harvest interval from the last application. Many of the EBDC uses are important during the early to midseason growth period and the days to harvest interval could easily be lengthened. By extending the days to harvest interval, the levels of residue on the harvested commodity would be greatly reduced.